

1 **COMMENTS OF JAMES B. ATKINS, Ph.D.**

2 **IN**

3 **PSC SC DOCKET NO. 2008-196-E**

4

5

6 **Q. PLEASE STATE YOUR NAME, AFFILIATION AND ADDRESS.**

7 A. My name is James B. Atkins, and I am a customer of South Carolina  
8 Electric and Gas Company (SCE&G) reside at 157 Preserve Lane, Columbia,  
9 South Carolina. I am also the President of Regulatory Heuristics, LLC, a single  
10 member consulting firm specializing in energy and environmental policy issues.  
11

12 **Q. PLEASE STATE YOUR EDUCATIONAL BACKGROUND.**

13 A. I received a Bachelors of Science degree in Marine Science from the  
14 University of South Carolina in 1976, a Masters of Science degree in  
15 Environmental Systems Engineering from Clemson University in 1981, and a  
16 Ph.D. in Marine Science from the University of South Carolina in 1998. My  
17 dissertation focused on the optimal sizing of offstream reservoirs which are used  
18 as an alternative water supply during drought conditions. This research included  
19 demand side management ("DSM") routines to minimize on-peak pumping costs  
20 for the water utility. I am also a certified mediator through the S. C. Council for  
21 Conflict Resolution.  
22

23 **Q. PLEASE BRIEFLY DESCRIBE YOUR RELEVANT EXPERIENCE.**

24 A. Since 2004, I have worked under contract with the Institute of Public  
25 Utilities at Michigan State University and the Critical Infrastructure Protection  
26 Program at George Mason University School of Law. This work has focused on  
27 critical infrastructure protection policies in the public utility sector, analysis of  
28 cost recovery in the electricity industry following the 2004-2005 hurricanes in the  
29 Gulf Coast, and the evaluation of State Energy Emergency Response Plans.

1           From 2000 to 2004, I represented the 2<sup>nd</sup> Congressional District as a  
2 member of the Public Service Commission of South Carolina ("Commission")  
3 and was a member, and past Vice Chair, of the Energy Resources and  
4 Environment Committee of the National Association of Regulatory Utility  
5 Commissioners ("NARUC"). I was also a member of the NARUC Board of  
6 Directors and served as Chair of the Subcommittee on Administration which  
7 oversaw NARUC's research and educational activities. I also represented  
8 NARUC as the Eastern U.S. State Regulatory representative on the Planning  
9 Committee of the North American Electric Reliability Corporation, and at the side  
10 conference on International Clean Energy Collaboration at the 2002 UN Framework  
11 Convention on Climate Change, COP-8, in New Delhi, India.

12           Prior to my service on the Commission, I was a research associate  
13 professor at the Earth Sciences & Resources Institute at the University of South  
14 Carolina where my research interests focused on drinking water protection,  
15 energy and water optimization modeling, environmental geographic information  
16 system mapping and environmental mediation. I was also a member of the  
17 extension faculty at North Carolina State University where I worked on animal  
18 waste management issues, agricultural non-point source pollution and on-farm  
19 energy efficiency. I have also worked as an engineer and scientist with a number  
20 of federal and state environmental agencies in South Carolina and North Carolina.  
21 Much of my work focused on water resources management issues including  
22 reservoir modeling regarding Federal Energy Regulatory Commission relicensing  
23 of hydropower facilities.

24  
25 **Q.   WHAT IS THE PURPOSE OF YOUR COMMENTS IN THIS**  
26 **PROCEEDING?**

27 A.       The purpose of my comments is to provide an alternative analysis of  
28 SCE&G's demand forecasting, and conclusions on the potential effectiveness of  
29 their DSM efforts. I will also present certain evidence to the Commission  
30 concerning the issue of affordability should the certificate and associated rate  
31 increase be granted going forward.

1  
2 **I. SCE&G'S DEMAND FORECASTING**  
3

4 **Q. WHAT ARE YOUR COMMENTS CONCERNING SCE&G'S DEMAND**  
5 **FORECASTING CONTAINED IN THE JOINT APPLICATION?**

6 A. I reviewed the direct and rebuttal testimony, and exhibits of Dr. Lynch. I  
7 also reviewed the revised May 2008 Integrated Resource Plan (IRP) submitted in  
8 support of the Application. My comments are as follows:  
9

- 10 • Despite the tens of millions of dollars spent to date regarding the planning,  
11 design and regulatory aspects of this proposed facility, the need for the  
12 proposed facility is only as good as the soundness and reasonableness of the  
13 assumptions, and the “accuracy” and “goodness” of the models finally  
14 selected. It is therefore imperative that the Commission fully understand the  
15 forecasting methodology used by SCE&G, as well as the assumptions used  
16 within the short and long-range forecasts.  
17
- 18 • In Appendix A of the May 2008 IRP, SCE&G provides an overview of the  
19 statistical **methodology** used in their short range forecasts, while Appendix B  
20 contains the long range forecasting methodology. For example, on p. B-3 of  
21 the IRP, variables used in the development of the demand forecasts including  
22 “measures of economic well being or activity” and “major economic events”  
23 are modeled. However, the IRP, nor Dr. Lynch’s direct testimony, exhibits or  
24 rebuttal testimony fails to include any qualitative or quantitative listing of the  
25 **assumptions** used in the model(s). **It is important to understand that**  
26 **methodology does not equal assumptions.** Without a complete  
27 understanding of these assumptions, and their respective effects on the final  
28 modeled forecasts, the Commission is placed in a position to trust that  
29 SCE&G’s assumptions are both **correct and current**. For example, the May  
30 2008 IRP was completed prior to a full understanding of the current

1 significant economic recession. It is critical for the Commission to fully  
2 understand what impact the significant economic recession will have on  
3 delaying the estimated 2016 (need) timeline for completion of the first reactor.  
4

- 5 • In fact, Section 58-37-10, (2) of the SC Code defines an IRP as

6 “Integrated resource plan” means a plan which contains the  
7 **demand and energy forecast** for at least a fifteen-year period,  
8 contains the supplier’s or producer’s program for meeting the  
9 requirements shown in its forecast in an economic and reliable  
10 manner, including both demand-side and supply-side options, with  
11 a brief description and summary cost-benefit analysis, if available,  
12 of each option which was considered, including those not selected,  
13 sets forth the **supplier’s or producer’s assumptions** and  
14 conclusions with respect to the effect of the plan on the cost and  
15 reliability of energy service, and describes the external  
16 environmental and economic consequences of the plan to the  
17 extent practicable.  
18

- 19 • As required under Section 58-37-10, (2), it is my recommendation that the  
20 Commission require SCE&G to provide a late-filed exhibit containing a  
21 detailed listing of all assumptions used in their statistical models used to  
22 forecast both demand and energy. I would further recommend that all parties  
23 in this case be provided an opportunity to review these assumptions and  
24 question SCE&G’s and the Office of Regulatory (ORS) Staff’s Panel  
25 concerning the validity of the assumptions. It is my professional (lay) opinion  
26 that without a detailed accounting of these assumptions, the Commission can  
27 not make an informed decision concerning the timely need of the proposed  
28 reactors as required under the Utility Siting Act and the Baseload Review Act.  
29

1       • SCE&G also failed to provide any detailed accounting of the various  
2       statistical testing metrics which measure the “goodness” of the models. Some  
3       of these are listed on p. B-2 of the May 2008 IRP. Model **assumptions** are  
4       often “tweaked” to improve model fit and the final “goodness” of the forecast.  
5       Understanding these statistical metrics of “goodness” is critical for the  
6       Commission in making an informed finding of fact concerning the need for  
7       the proposed reactors. On p. A-3 of the May 2008 IRP, SCE&G states that  
8       “Some models revealed a decreasing trend in average use...However, other  
9       models showed an increasing average use over time...” How did SCE&G  
10      determine which model to use? This is a perfect example of the importance of  
11      understanding the impacts which various model assumptions can have on the  
12      final forecasts and the ultimate “statistical goodness” of the models used. It is  
13      my recommendation that the Commission require SCE&G to provide a late-  
14      filed exhibit containing a detailed listing of all statistical testing “goodness”  
15      metrics in their statistical models used to forecast both demand and energy, as  
16      well as the “goodness” metrics for models not selected. Such a request may  
17      seem somewhat “geeky”, but in reality is required for the Commission to  
18      determine the prudence of SCE&G’s forecasted need, especially for a multi-  
19      billion dollar proposed project. **Many a project has failed or been over or**  
20      **under-built based on invalid assumptions and lack of robust model**  
21      **development.**

22  
23      • In response to the testimony provided by ORS panelist Dr. Zhen Zhu,  
24      examining the accuracy of past forecasts is not a substitute for a rigorous  
25      evaluation of the statistical (modeling) methodologies, model assumptions and  
26      “goodness” metrics of SCE&G’s May 2008 IRP. Only time will tell whether  
27      or not the May 2008 IRP forecast provides an under or over estimate of the  
28      demand. It is not asking much that short term forecasts provide a fairly high  
29      degree of accuracy as indicated by Dr. Zhen Zhu. The real issue of accuracy  
30      arises when forecasting 10 to 15 years into the future needed with the long

1 regulatory and construction times for nuclear facilities. To obtain a more  
2 complete indication of SCE&G's prior forecasting error, the ORS should have  
3 tested **all** prior SCE&G forecasts to determine the error in the 10 to 15 year  
4 portion of the forecasts. As such, it is my professional (non-legal) opinion that  
5 Dr. Zhen Zhu's testimony fails to provide a robust statistical validation and  
6 assessment of SCE&G's forecasting methodology required to protect the  
7 public interest under 58-33-230, (F) of the Baseload Review Act. **Ratepayers**  
8 **need and deserve more than a few paragraphs of testimony from the ORS**  
9 **when being requested to fund a multi-billion dollar facility with a**  
10 **resultant 30-plus percent rate increase.**  
11

- 12 • I would respectfully request that the Commission take judicial notice of the  
13 docket pertaining to the Certificate of Public Convenience and Necessity for  
14 Duke Power's construction of the Catawba Nuclear Plant. In particular, the  
15 Catawba Nuclear Plant was approved based on forecasts which failed to  
16 accurately predict the large economic downturn of the 1970's and 1980's. As  
17 a direct result, the investors in the plant, such as the Piedmont Municipal  
18 Power Association (PMPA), were placed in financial jeopardy and ultimately  
19 had to be bailed out by the U.S. Rural Utility Service. It is my understanding  
20 that loan will not be paid off for another 20 to 30 years. The current  
21 Commission should not venture down a similar path regarding the imprudent  
22 construction of unneeded nuclear capacity based on faulty or inaccurate  
23 forecasts. Additionally, the Commission must consider the economic impact  
24 to ratepayers of "securitizing" the expense of an imprudently-approved  
25 nuclear reactor given the erroneous and regressive provisions in Section 58-  
26 33-275 of the Baseload Review Act regarding cost recovery and prudence.

27  
28 **Q. DID YOU REVIEW SCE&G'S DEMAND FORECASTING CONTAINED**  
29 **IN THE JOINT APPLICATION?**

1 A. Yes. I reviewed the final forecasts contained in the May 2008 IRP. I  
2 produced a series of graphs which are contained in Atkins Exhibit 1. It is my  
3 professional opinion that this analysis raises a number of questions concerning the  
4 assumptions used by SCE&G and the final 2008 forecast, in particular the potential  
5 over-estimation of demand in the 2017 to 2022 timeframe.

6  
7 **Q. HOW DID YOU APPROACH YOUR REVIEW?**

8 A. A common approach used in statistical design, and regression analysis,  
9 employees the blocking of data. Blocking consists of arranging data into groups  
10 (blocks) that are similar. Think of comparing apples to apples. In the case of the  
11 SCE&G historical demand data, one block consisted of the historical demand  
12 including large off-system sales to the North Carolina EMC (hereinafter NC) from  
13 2004 through 2012. A second block consisted of the historical demand minus the  
14 large off-system sale to NC. This sale ranged from 350 MW to 250 MW.

15  
16 Figure 1 (in Atkins Exhibit 1) shows the demand from 1978 through 2007  
17 for SCE&G including and excluding the off-system sale to NC. A linear regression  
18 model was fitted to each data set and the resultant regression equation and coefficient  
19 of determination ( $R^2$ ) are shown. For both equations, over 98% of the variability in  
20 peak annual demand is explained by time (year of occurrence). A perfect fit equals  
21 1.0. The demand, including the NC sale, demand grew (on average) 91 MW each  
22 year, while demand grew only 83 MW each year excluding the sale to NC. Thus, the  
23 second regression equation represents demand growth had the sale to NC not  
24 occurred.

25  
26 Figure 2 shows the historical peak demand from 1993 through 2007 for  
27 SCE&G and the May 2008 IRP forecasted demand, both inclusive of the off-system  
28 sale to NC through 2012. Note that compared with Figure 1, the demand growth  
29 increased from 91 MW per year to 106 MW per year. The 2008 forecasted demand  
30 has been plotted and fits directly on top of the regression line based on the 1993

1 through 2007 time period which includes the NC sale. When the sale to NC  
2 terminates in 2012, the forecast line is observed to adjust downward and then  
3 continue an upward trend almost parallel to the 1993-2007 regression line.  
4

5 Figure 3 shows the historical peak demand from 1993 through 2007 for  
6 SCE&G including and excluding the off-system sale to NC and the May 2008 IRP  
7 forecasted demand excluding the off-system sale to NC for 2008 and 2009. Note that  
8 based on the historical demand from 1993 through 2007, SCE&G demand is  
9 increasing at a rate of 81 MW each year. Removing the 2008 and 2009 short term  
10 forecasts, the 2008 forecasts from 2010 through 2022 have been plotted. A regression  
11 equation was fitted to these data and a growth rate of 110 MW per year is forecasted.  
12 Remember, these are the exact forecasts contained in the May 2008 IRP and have  
13 been adjusted downward to account for the termination of the sale to NC. Figure 3  
14 clearly shows that the 2008 forecasts are under the regression line based on the  
15 demand data including NC. However, the 2008 forecasts over-estimate demand  
16 compared with the demand data with NC removed.  
17

18 Finally, Figure 4 shows the historical peak demand from 1993 through  
19 2007 for SCE&G including and excluding the off-system sale to NC and the May  
20 2008 IRP forecasted demand excluding the off-system sale to NC. Examining the  
21 demand including the NC sale first, the 250 MW sale to NC was added back onto the  
22 2008 forecasts from 2013 through 2022. As seen in Figure 4, the forecasted demand  
23 from 2010 to 2022 fits directly on top of the regression line based on the demand  
24 from 1993 through 2007. In other words, had the sale to NC not been terminated, the  
25 2008 forecasts coincide almost perfectly to the regression line based on the SCE&G  
26 historical demand including the sale to NC. (Demand w/ NC =  $106.87 * (\text{Year}) - 209589$ ) ( $R^2=0.98$ ).  
27  
28

29 However, removing the sale to NC from 2004 through 2012 and then  
30 plotting the 2008 forecasts shows that the 2008 forecasts are well above the

1 regression line based on historical demand data blocked to exclude the NC sale  
2 (Demand w/o NC=  $81.079 \times (\text{Year}) - 158090$ ) ( $R^2=0.90$ ). This regression equation  
3 would have been representative of SCE&G's demand had the sale to NC never  
4 existed. If the regression equation including the NC sale accurately models the 2008  
5 forecasts (adjusted to include the NC sale), then why does the regression equation  
6 excluding the NC sale not also accurately describe the 2008 forecasts since the  
7 SCE&G 2008 forecasts do not model the NC sale beyond 2012? Had SCE&G applied  
8 a common factor to escalate the demand forecasts, I would conclude that the rate of  
9 increase in the forecasts (slope of the regression lines) would have been above that  
10 observed for both regression lines. However, the 2008 forecasts are only above the  
11 regression line excluding the sale to NC. From a practical, common-sense statistical  
12 approach, the 2008 forecasts are inconsistent with past historical trends.

13  
14 **It is my professional (non-legal) opinion that this simple analysis**  
15 **brings into question the validity of SCE&G's 2008 forecast, and that the 2008**  
16 **forecasts over-estimate the demand especially in the long-term when the first**  
17 **reactor will be required.** For example, the 2008 forecasts state that a demand of  
18 5,697 MW is required in 2017. Based on the regression equation blocked to exclude  
19 the NC sale, only 5,446 MW would be needed (251 MW less). In 2020, 6,037 MW  
20 are required under the 2008 forecasts, while the regression equation blocked to  
21 exclude the NC sale indicates 5,690 MW is required (347 MW less). **If accurate,**  
22 **these differences are significant, and bring into question the timing and**  
23 **prudence of SCE&G's application. However, since SCE&G failed to provide the**  
24 **forecasting (model) assumptions and statistical "goodness" metrics" as discussed**  
25 **previously I have no specific data to confirm my opinion, and neither does the**  
26 **Commission.**

## 27 28 **II. DEMAND-SIDE MANAGEMENT EFFORTS** 29

1 **Q. WHAT ARE YOUR COMMENTS CONCERNING SCE&G'S DSM**  
2 **EFFORTS CONTAINED IN THE JOINT APPLICATION?**

3 A. A review of the May 2008 IRP, and Dr. Lynch's testimony  
4 and exhibits provide a confusing and incomplete explanation of SCE&G's DSM  
5 efforts. To any informed reader, it is unclear the extent to which energy efficiency  
6 efforts impact or result in demand reduction through time. This should not be  
7 confused with the **available demand response** efforts of SCE&G of approximately  
8 200 MW which are known and measurable.

9  
10 **Q. WHAT REVIEW DID YOU CONDUCT OF SCE&G'S DSM EFFORTS**  
11 **CONTAINED IN THE JOINT APPLICATION?**

12 A. I reviewed data available in the IRPs of SCE&G, Duke and Progress  
13 Energy from 2000 through 2007 and also the NERC Long Range Assessments for the  
14 same period. Figure 5 shows the actual 10 year average demand growth from 2000  
15 through 2007 for SCE&G, VACAR members and SERC members. Data for VACAR  
16 and SERC was obtained from the NERC Long Range Assessments for each of the  
17 years included. I used the SERC data which was modified by NERC to provide for a  
18 uniform comparison since the SERC membership has changed in recent years. Figure  
19 5 demonstrates that the growth in demand has slowed within SCE&G's territory,  
20 VACAR and SERC. In 2000, the 10 year average demand growth ranged from 2.8%  
21 to 3.4 %. By 2007, demand growth had decreased to 1.7% to 2.5%. These data  
22 represent the "real world" outcomes of the various factors which influence demand  
23 growth such as population increases, net industrial growth, net commercial growth,  
24 and net residential growth in demand. So despite homes becoming larger with more  
25 appliances, for whatever reason, demand growth has slowed.

26  
27 **Q. DO YOU BELIEVE THIS IS IN RESPONSE TO THE DEMAND**  
28 **RESPONSE PROGRAMS OF SCE&G OR OTHER VACAR UTILITIES?**

29 A. No. Utilizing data from the IOU's IRPs in VACAR, Figure 6 clearly  
30 shows that the demand response programs of SCE&G, Duke and Progress Energy

1 have generally decreased since 2000. Note that Progress Energy has significantly  
2 increased its demand response efforts in the last two years. Therefore, since we know  
3 that population has increased with North and South Carolina since 2000, demand  
4 growth has slowed due to a decrease in industrial or commercial demand and/or the  
5 combined impact of energy efficiency efforts in also reducing demand.  
6

7 **Q. DID YOU CONDUCT A MORE SPECIFIC ANALYSIS OF SCE&G'S**  
8 **HISTORICAL AND FORECASTED DEMAND GROWTH?**

9 A. I did. Figures 7 and 8 show the time series of the historical 10 year and 15  
10 year, respectively, average growth in peak demand for SCE&G from 1978 to 2007,  
11 and the forecasted average growth in peak demand based on their May 2008 IRP.  
12 Both data series exclude the off-system sale to NC. From 1993 through 2007, the  
13 growth in demand without the sale to NC is shown to decrease by over 50% during  
14 the period. Again, adjusting the forecast to exclude the sale to NC from 2008 through  
15 2012, shows a significant reduction through 2012. After 2012, the 10 year demand  
16 growth forecast is shown to increase dramatically and then level off through 2022.  
17

18 This raises the question "What assumptions in the SCE&G May 2008 IRP  
19 resulted in a change in the downward trend observed in the past." This change is also  
20 contrary to the data trends shown for VACAR and SERC in Figure 5. This outcome  
21 would suggest a possible increase in demand from non-residential and/or residential  
22 customers. It is my opinion that such an outcome seems unlikely, especially given the  
23 current severe economic recession and the implementation of energy efficiency  
24 practices which also yield demand reductions slowing the growth in demand through  
25 time. Interestingly, if SCE&G forecasts were more closely aligned with the regression  
26 equation for demand growth blocked to exclude the NC sale (refer back to Figure 4),  
27 then the growth in demand would have exhibited a similar trend for the historical  
28 demand data shown in Figure 7. **Figures 7 and 8 also support my previous**  
29 **comments that the 2008 IRP forecasts over-estimate the future demand in the**  
30 **SCE&G system. It is my professional (non-legal) opinion that it will be exceeding**

1       difficult for the Commission to determine the prudence of SCE&G's Application  
2       and the need for the baseload generation without obtaining the model  
3       assumptions as previously suggested.  
4

5       **Q.     WHAT OPINION DO YOU HAVE REGARDING THE IMPACT OF**  
6       **ENERGY EFFICIENCY PRACTICES ON DEMAND REDUCTION?**

7       A.           Consistent with available studies, it is my professional opinion that certain  
8       energy efficiency practices also yield demand reductions. For example, the SEER 13  
9       and HVAC systems discussed in Dr. Lynch's testimony will not only reduce energy  
10      consumption but also, if properly installed, reduce summer peak demand. I have  
11      attached a study conducted in Florida to my comments which found that properly  
12      installed energy efficient HVAC systems will reduce **peak hour demand from 1.26**  
13      **kw up to 2.54 kw.** It is unclear from the May 2008 IRP or Dr. Lynch's testimony  
14      whether or not such demand reductions are included in the 2008 demand forecasts.  
15      The forecasted increases in the rate of demand growth seen in Figures 7 and 8 suggest  
16      such demand reductions may not have been included. Similar demand reductions are  
17      also possible through the implementation of energy efficiency practices such as  
18      lighting, weatherization, and efficient appliances and electronics. As a direct result of  
19      increasing utility costs, consumers have, and will continue to reduce demand through  
20      the implantation of energy efficiency practices. It is my professional opinion that  
21      much of the reductions in the historical growth of demand, shown in Figures 5, 7 and  
22      8, are the direct result of the penetration of such practices. The penetration of these  
23      practices will only increase given the outcomes of the recent 2008 National elections  
24      and a continued focus by consumers on reducing energy use, demand and costs.  
25      Please refer to the attached article regarding the announcement concerning the City of  
26      Columbia's energy efficiency lighting initiative.

27  
28               The importance of the inclusion of demand reduction can explained with a  
29      simple calculation. Assume that a SEER 13 system costs approximately \$5,000 to  
30      install, and that an average of 1.9 kw savings are assumed (based on the above

1 Florida study outcomes). Installing 5,440 efficient HVAC systems would cost \$27.2  
2 million and reduce peak hourly demand by 10.34 MW. If 5,440 HVAC systems were  
3 installed annually from 2008 through 2017, a total of 54,400 HVAC units would be  
4 installed at a cost of \$272 million and would result in a cumulative reduction of  
5 103.36 MW by 2017. Accounting for O&M costs and financing charges and  
6 providing the appropriate discounting techniques, the cost per MW is significantly  
7 less than construction of a central coal or nuclear generating station.

8  
9 The above scenario of HVAC installation is not unreasonable. Further,  
10 under Section 58-37-20 of the SC Code, SCE&G could finance all or a part of the  
11 HVAC installations, earn a rate of return on that investment and recover the lost  
12 revenues associated with the efficiency practices. **It is my recommendation that the**  
13 **Commission request SCE&G to file a late-filed exhibit further outlining the**  
14 **feasibility of investing in energy efficiency and demand reduction using such an**  
15 **approach. As a hypothetical, what energy and demand reductions could be**  
16 **realized if SCE&G invested \$1 billion in such practices? What would be the final**  
17 **costs to the utility and the consumer and how would these costs compare with**  
18 **SCE&G's current application?**

19  
20 **Q. WHAT OTHER ANALYSIS DID YOU CONDUCT CONCERNING**  
21 **SCE&G'S DEMAND DATA?**

22 **A.** Based on information provided in ORS information request 1-54, I  
23 examined the peak hourly demand for the four largest peak hours during each year.  
24 These data are presented in Figures 9 through 13. Figure 9 shows a time series of the  
25 peak hourly demand, 2<sup>nd</sup> highest peak hourly demand, 3<sup>rd</sup> highest peak hourly demand  
26 and the 4<sup>th</sup> peak hourly demand for each year from 2000 through 2007 for SCE&G.  
27 The hourly demand is shown to increase with time. During some years, very little  
28 difference was observed between the peak hourly demands while in other years, a  
29 significant difference was observed between the peak hour demand and the 2<sup>nd</sup>, 3<sup>rd</sup>  
30 and 4<sup>th</sup> highest hourly demands.

1 For the 30 year period from 1978 through 2007, the peak hourly demand  
2 occurred from 4 PM to 5 PM in 15 years (or 50% of the years). To better visualize  
3 these data, I subtracted the 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> highest hourly demands in each year from  
4 the peak hourly demand for that year. The results are shown in Figure 10. The  
5 smallest difference was observed in 1993 with only 16 MW difference between the  
6 peak hour and the 4<sup>th</sup> highest peak hour. In other words, the peak demand plateaued  
7 for almost four hours. In contrast, during 2006, the hourly peak was steep with the  
8 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> highest peak demand being 37 MW, 63 MW and 112 MW less than the  
9 peak hour demand, respectively.

10  
11 To better illustrate these data, Figures 11 through 13 show each individual  
12 time series contained in Figure 10. All can be seen to trend downward suggesting that  
13 since 1978, the peak hourly demand in the SCE&G has become more peaked in  
14 character. So why is this important? The characterization of the peak hourly data is  
15 important regarding the effectiveness of demand response and demand reductions  
16 obtained through the implementation of energy efficiency practices. If the peak  
17 hourly demand is flat and last for two or more hours, it becomes difficult to request  
18 customers to drop or reduce demand. However, as the peak hourly data becomes  
19 steeper, the potential is increased to reduce the demand during the one peak hour. For  
20 example, refer to Figure 11. In recent years, if demand could have been reduced  
21 during the one peak hour, the 2<sup>nd</sup> highest hour was from 10 to 40 MW less which is  
22 not insignificant. In recent years, the 3<sup>rd</sup> highest hour was from 20 to 60 MW less  
23 than the peak hour demand (refer to Figure 12). If the trends in Figures 10 through 13  
24 continue, important reductions in the peak hourly demand can be realized by a  
25 renewed focus on the one peak hourly which comprises a huge portion of the capital  
26 cost to provide reliable service and to comply with NERC Standards. **It is my**  
27 **recommendation that the Commission request that SCE&G file a late filed**  
28 **exhibit further analyzing their hourly demand data especially in regard to the**  
29 **implications of energy efficiency practices on reducing the peak hourly demand**  
30 **as exemplified in the attached Florida Study previously referenced. Better**

1 understanding these hourly data could demonstrate that the construction of the  
2 nuclear reactors, especially the second unit, could be delayed and still provide  
3 reliable electric service.

### 4 5 III. AFFORDABILITY ISSUES

#### 6 7 Q. WHAT COMMENTS DO YOU HAVE REGARDING AFFORDABILITY 8 ISSUES?

9 A. With the current severe economic recession, residential and small business  
10 customers of SCE&G will have an increasingly difficult time in the coming years(s)  
11 paying an electric bill estimated to increase by 37% associated singularly with the  
12 proposed nuclear facility. This says nothing about the other potential rate increases  
13 associated with increased fuel costs and construction of peaking units.

14  
15 Figure 14 and 15 show time series, from the 2<sup>nd</sup> Qt 2007 through the 3<sup>rd</sup> Qt  
16 of 2008, of SCE&G's delinquent notice of payments issued, the total number  
17 completed, the resulting total number of terminations during each quarter (data from  
18 Docket No. 2006-193 E/G). Approximately 100,000 customers every quarter are  
19 currently in some type of payment delinquency with 20,000 to 30,000 actually  
20 receiving a termination notice each quarter. While only a smaller percentage of  
21 customers are terminated, around 5,000 to 6,000 per quarter, this should not be  
22 viewed as insignificant. Although this is a small number to SCE&G, if you are the  
23 residential or small business customer who has lost power, it is more than significant.  
24 **If it does not already systematically review these data, I would respectfully**  
25 **request that the Commission monitor such data to determine the impact of the**  
26 **economic downturn and increased rate increases on the delinquency and**  
27 **termination of SCE&G's customers.**

28  
29 A final thought on this subject concerns a cautionary tale concerning  
30 Section 58-33-275 of the Baseload Review Act and cost-recovery of generating

1 facilities. Section 58-33-275 makes a somewhat skewed, and potentially dangerous  
2 conclusion, in that the “base load review order shall constitute a final and binding  
3 determination that a plant is used and useful for utility purposes, and that its capital  
4 costs are prudent utility costs...” While this may protect the interest of the IOU, it  
5 fails to provide any protection to the utility customer and may not represent the future  
6 energy use reality.

7  
8 The following scenario is provided as an example. Assuming the  
9 Commission approves the current application, SCE&G proceeds with plant  
10 construction and a series of annual rate increases are imposed. An increasing number  
11 of financially stressed residential and small business customers are either terminated  
12 or are unable to consistently pay their bills in a timely manner. As a direct result of  
13 these price increases, customers begin a focused effort to conserve energy and reduce  
14 demand in order to reduce their bills. This focus escalates as rates increase later in the  
15 decade and as federal and other State tax credit efforts promote energy efficiency and  
16 demand reduction. Penetration of these practices is further enhanced due to lower unit  
17 costs for energy efficient HVAC systems, appliances, lighting and electronics,  
18 improved building standards and as more customers switch to cheaper distributed  
19 generation such as thin-film solar panels. Because SCE&G failed to accurately  
20 predict such events, revenues decrease due to reductions in electricity sales. From a  
21 real perspective, much of the capacity of the nuclear plant will not be “used and  
22 useful” until some later date and could be said to have been an imprudent decision.  
23 This is a similar scenario to what happened regarding Duke Power’s Catawba Nuclear  
24 Plant referenced earlier.

25  
26 In essence, the Commission and SCE&G will have “securitized” these  
27 plant expenses onto the backs of the ratepayers with no relief in sight since Section  
28 58-33-275 of the Baseload Review Act fails to consider such a scenario. A similar  
29 analogy has just occurred with security-backed mortgages. The purchasers of these  
30 mortgages never envisioned that the mortgage holder would default on their mortgage

1 payment. However, that is exactly what has transpired resulting in a severe world-  
2 wide credit crisis. If enough of SCE&G customers are unable to pay their electric  
3 bills, and as more and more customers conserve and switch to alternative sources of  
4 energy, SCE&G could find themselves in a similar position to the holders of  
5 mortgage-backed securities.

#### 6 7 **IV. FINAL RECOMMENDATIONS**

8  
9 In conclusion, it is imperative that the Commission carefully and judicially  
10 consider the approval of this application. Once the decision is made, there is no  
11 turning back due to the provisions of the Baseload Review Act. The economic well-  
12 being of the State and SCE&G rest in the hands of the Commission. Based on my  
13 review of this application and testimony in this docket, my recommendations follow:

- 14
- 15 • Should the Commission find that the reactor design is acceptable and safe, and  
16 that the reactor can be constructed as on time and on budget as testified to, and  
17
  - 18 • That adequate independent analysis has been conducted to insure that  
19 adequate cooling water exists and that use of such water will not negative  
20 other downstream water uses (both offstream and instream), and  
21
  - 22 • That SCE&G can demonstrate, based on the soundness and accuracy of their  
23 forecasting assumptions, that their short term (5 year) forecasts are accurate,  
24 then I would recommend  
25
  - 26 • That the Commission approve the initial reactor, but not the second reactor as  
27 proposed. The Commission should require SCE&G to refile its application,  
28 and in doing so account for changes in technology and market (economic)  
29 conditions on the timing and need for the second reactor, and  
30

- 1       • That the Commission order SCE&G to develop a energy efficiency program  
2       focused on both energy and demand reduction, and that such program be  
3       operational prior to filing any subsequent application to construct the second  
4       reactor.

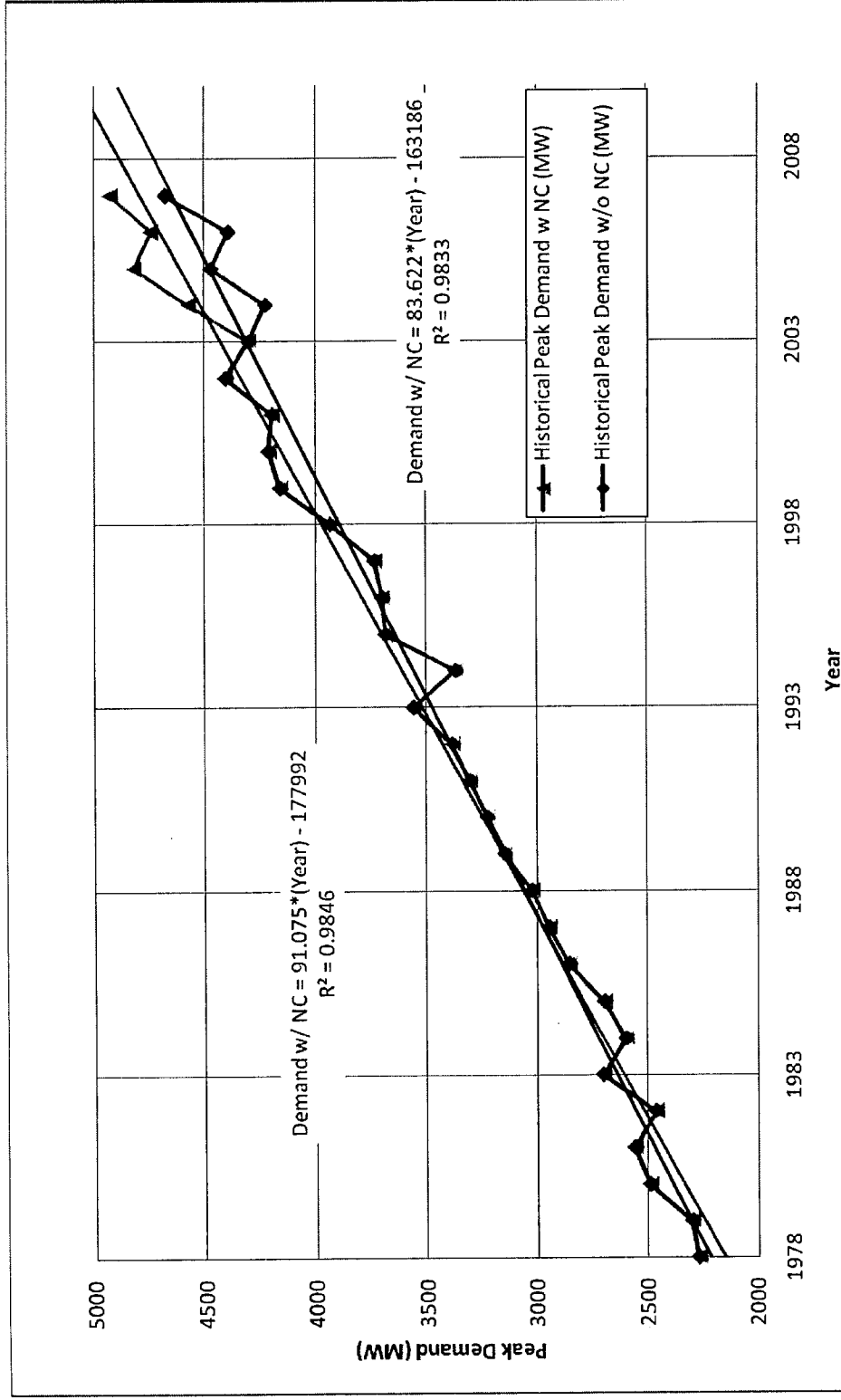


Figure 1. Historical peak demand from 1978 through 2007 for SCE&G including and excluding the off-system sale to NCEMC.

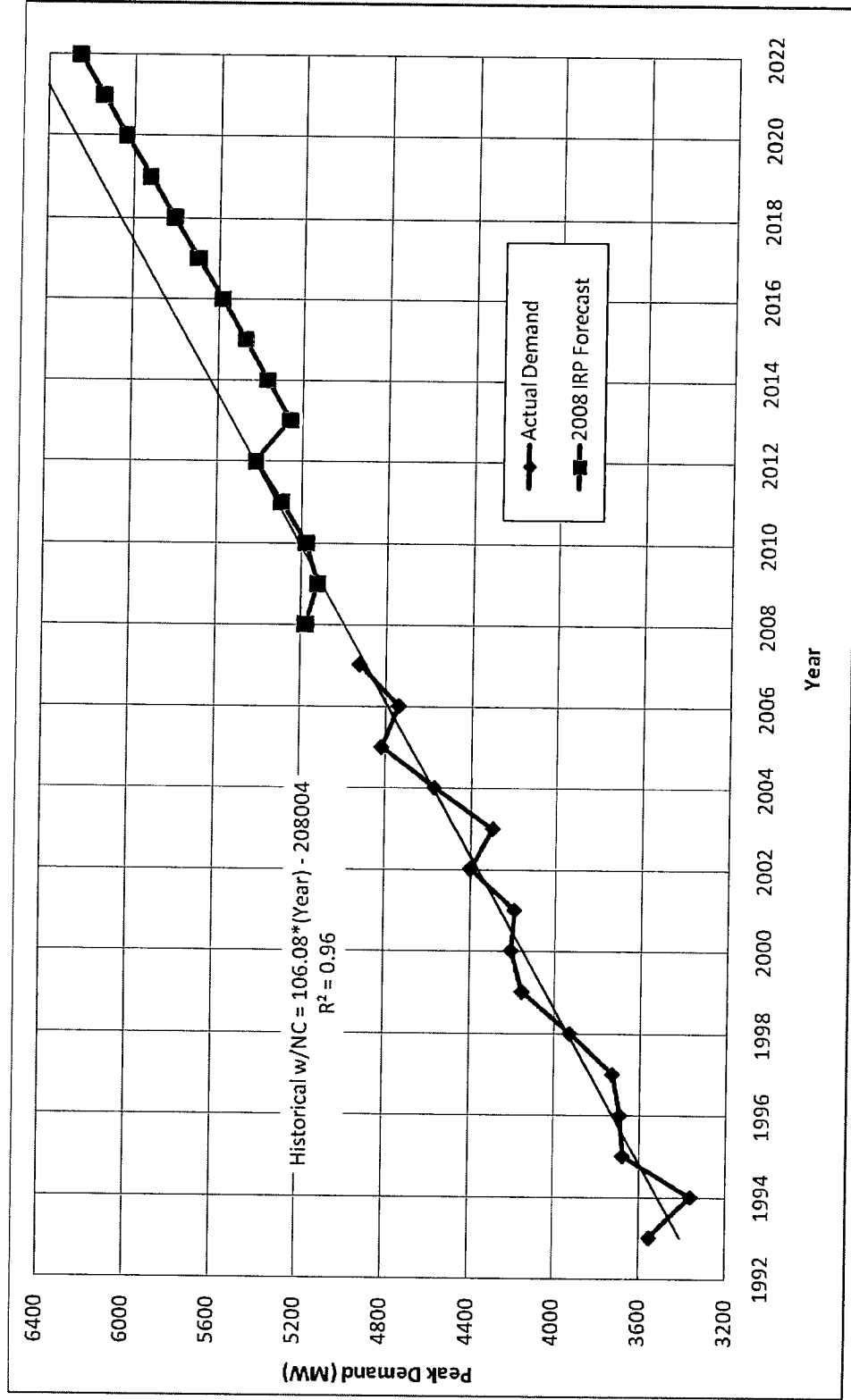


Figure 2. Historical peak demand from 1993 through 2007 for SCE&G including the sale to NC, and the May 2008 IRP forecast demand, both inclusive of the off-system sale to NCEMC through 2012.

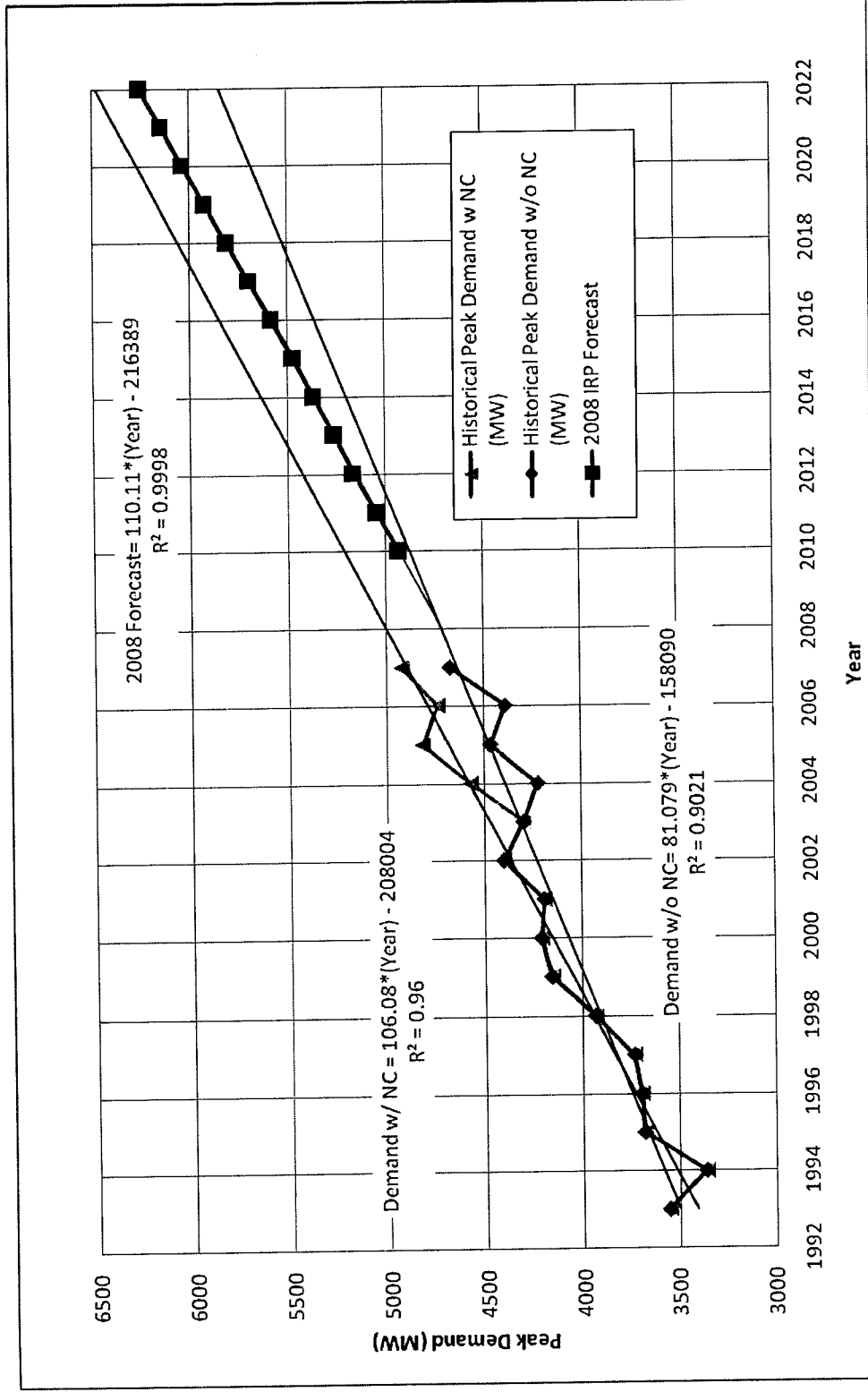


Figure 3. Historical peak demand from 1993 through 2007 for SCE&G including and excluding the off-system sale to NCEMC and the May 2008 IRP forecasted demand excluding the off-system sale to NCEMC.

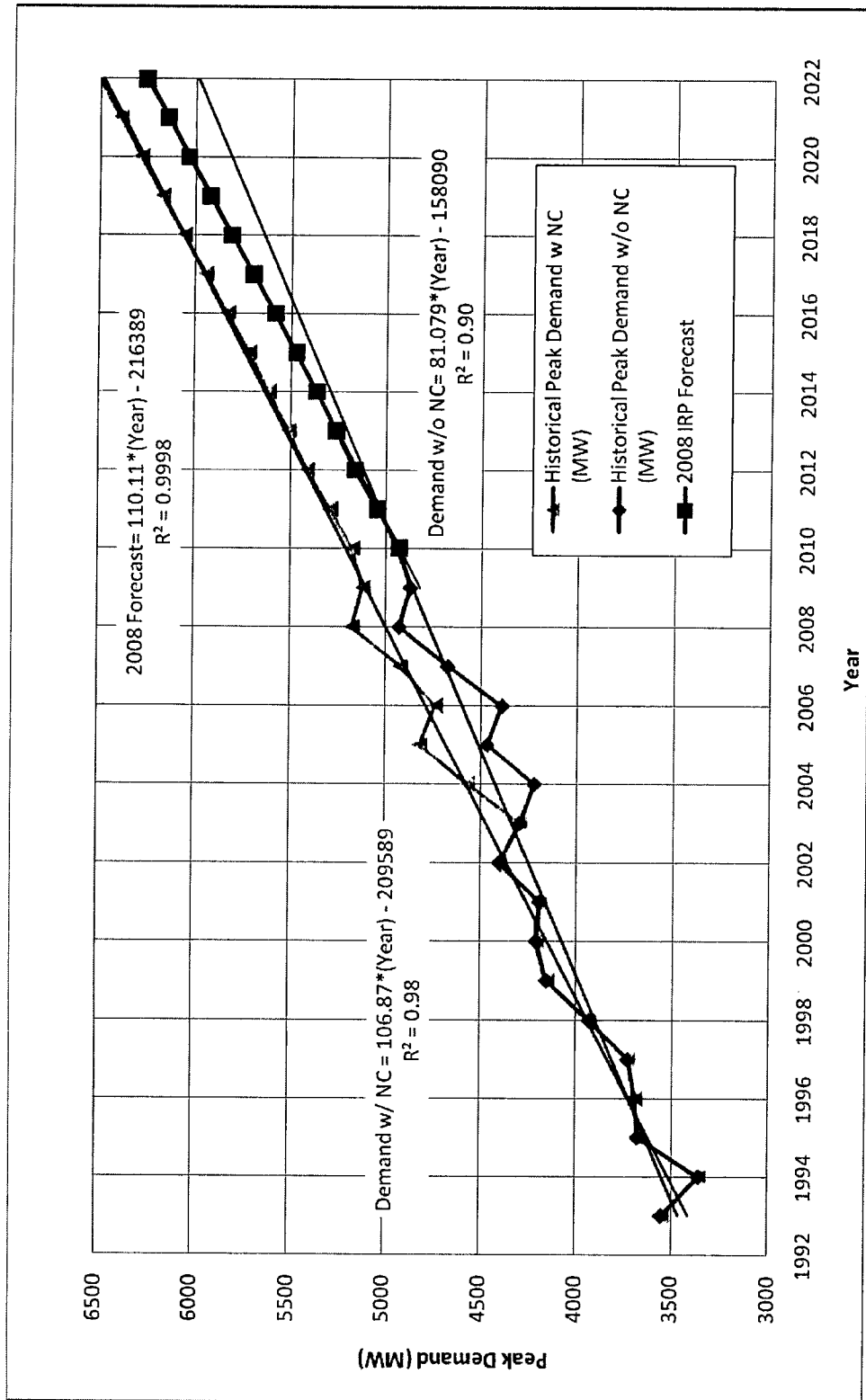


Figure 4. Historical peak demand from 1993 through 2007 for SCE&G including and excluding the off-system sale to NCEMC and the May 2008 IRP forecasted demand excluding the off-system sale to NCEMC.

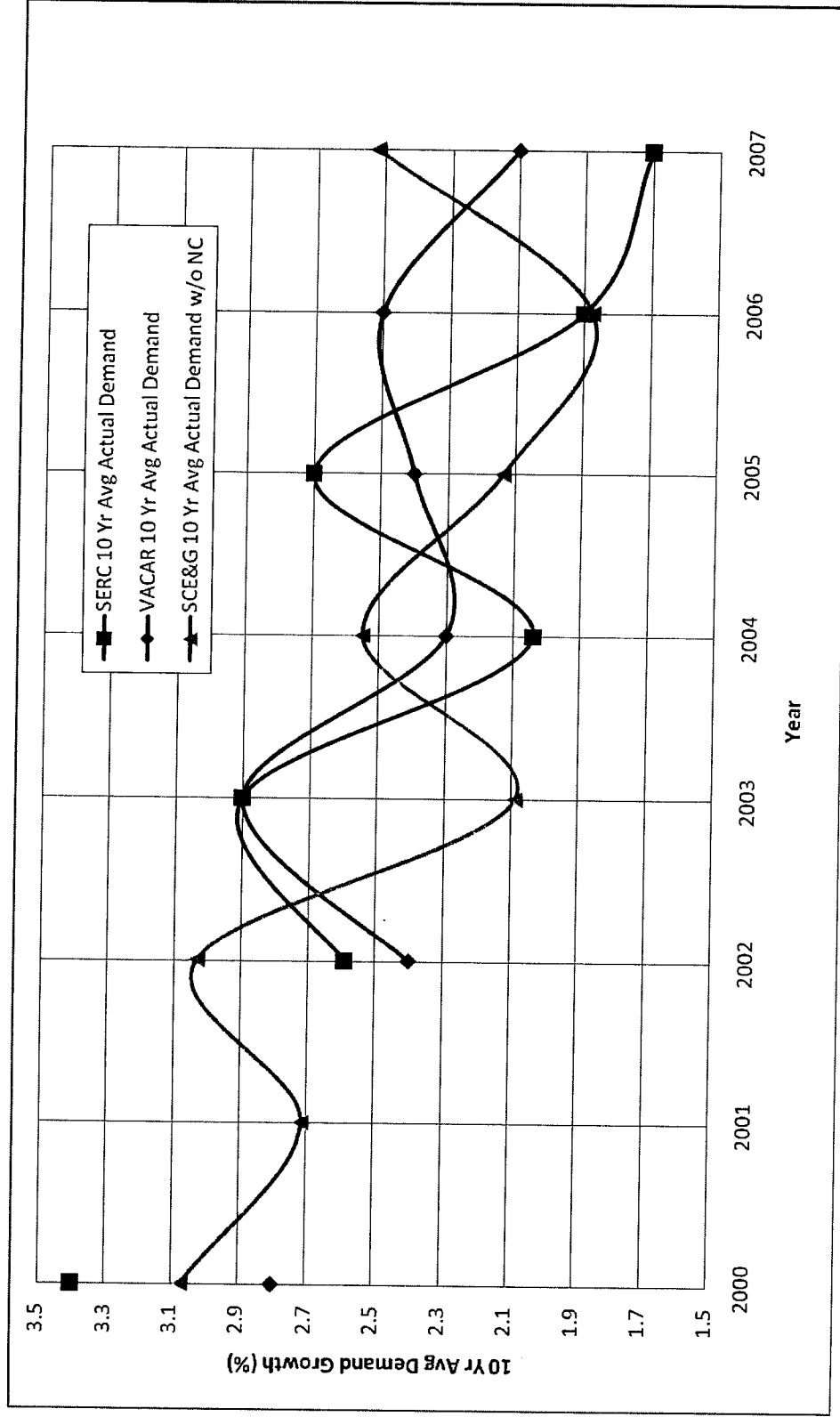


Figure 5. Actual 10 year average demand growth from 2000 through 2007 for SCE&G, VACAR members and SERC members. Data for VACAR and SERC was obtained from the NERC Long Range Assessments for each of the years included. SERC data were modified by NERC to provide for a uniform comparison since the SERC membership has changed in recent years.

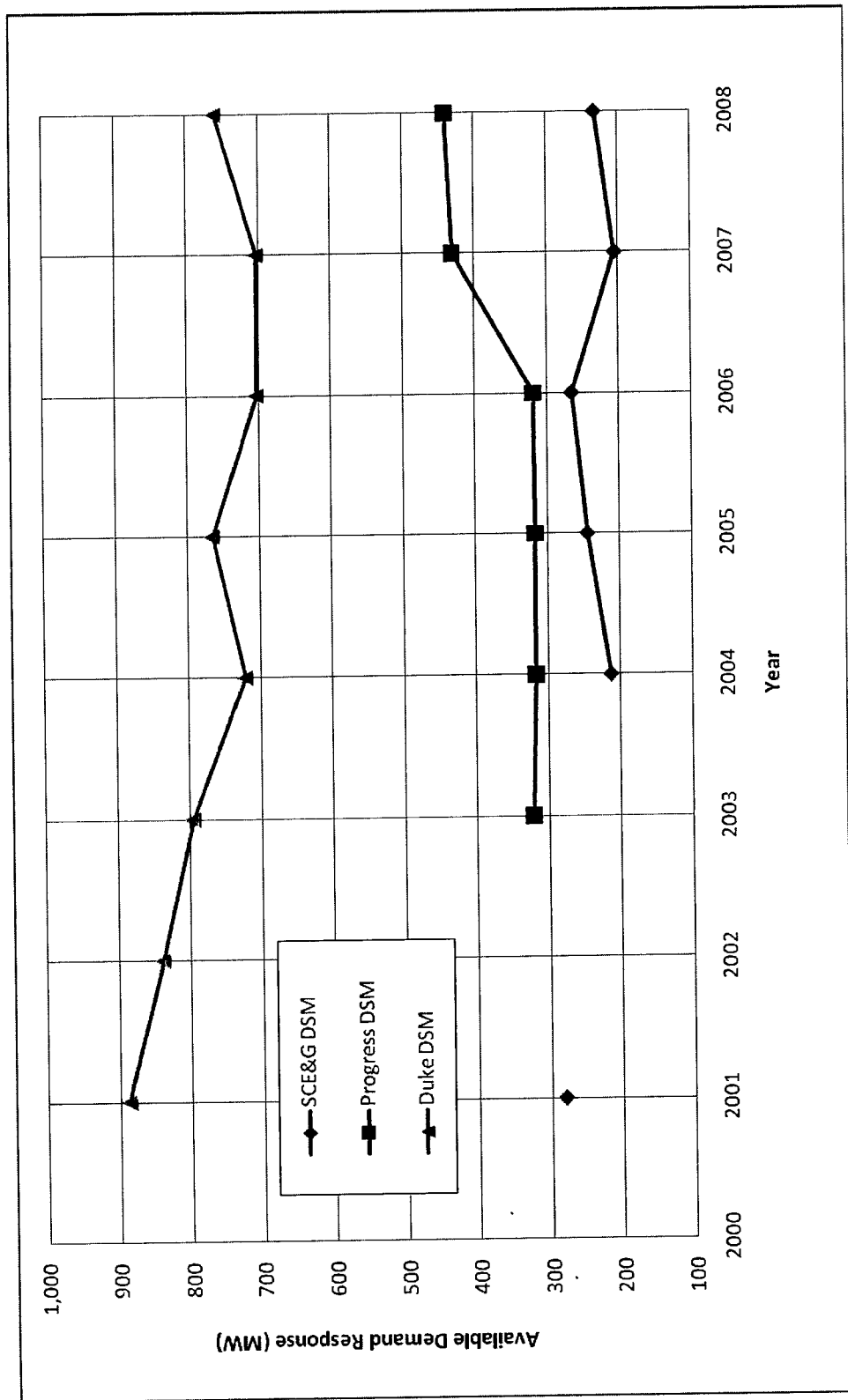


Figure 6. Comparison of available demand response programs reported in their respective IRPs for SCE&G, Duke and Progress Energy.

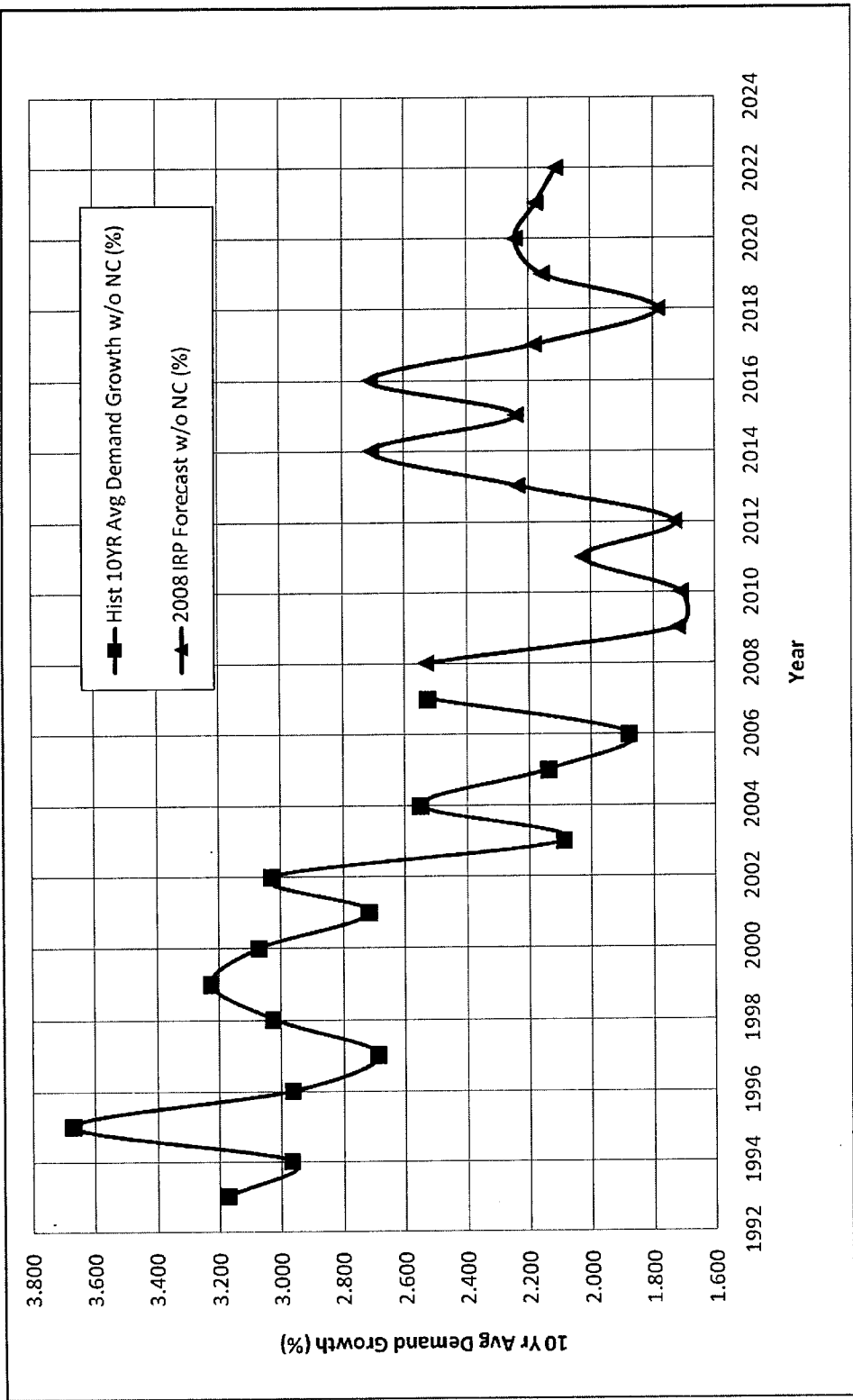


Figure 7. Time series of the historical 10 year average growth in peak demand for SCE&G from 1978 to 2007, and the forecasted 10 year average growth in peak demand based on their May 2008 IRP. Both data series exclude the off-system sale to NCEMC.

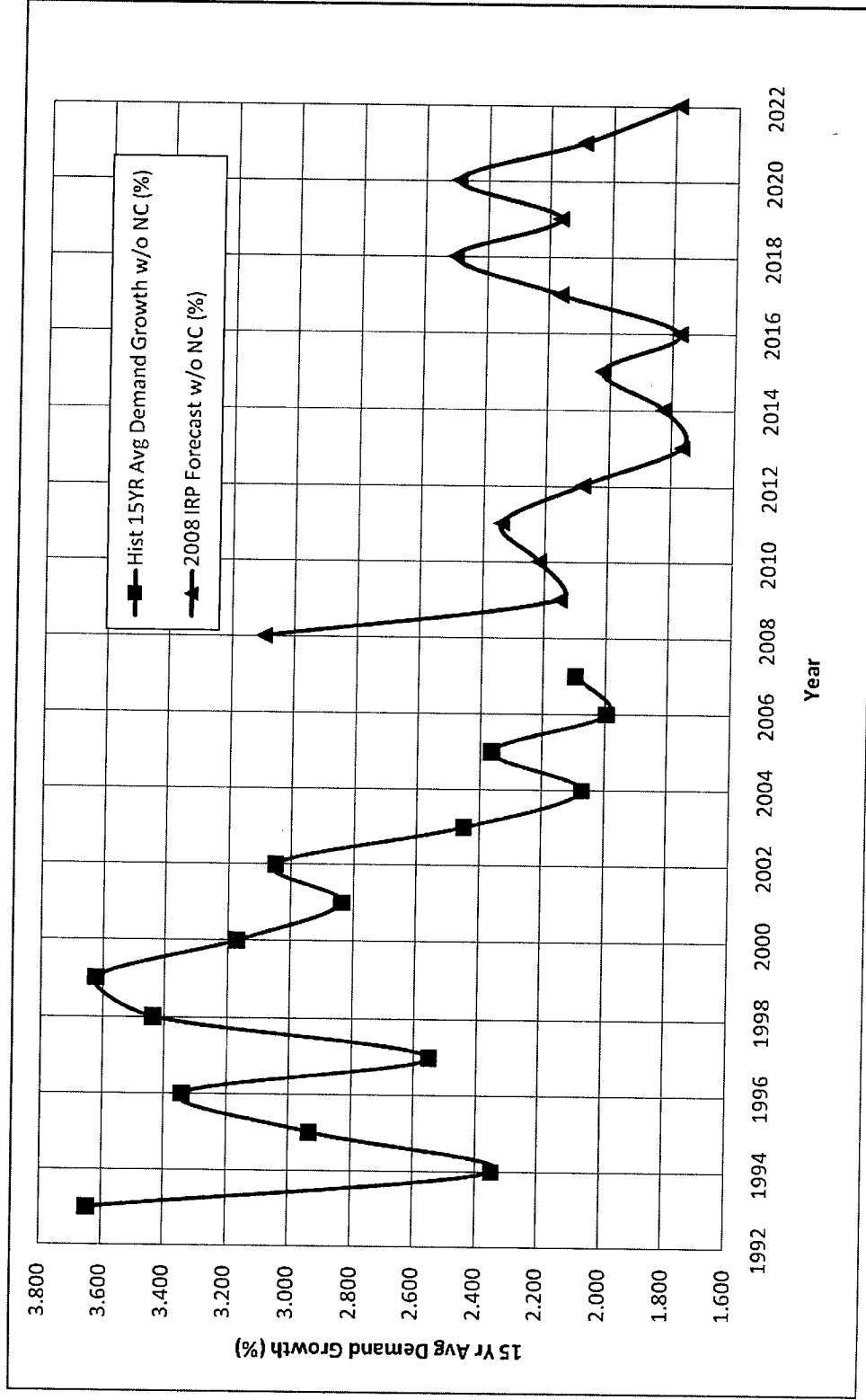


Figure 8. Time series of the historical 15 year average growth in peak demand for SCE&G from 1978 to 2007, and the forecasted 15 year average growth in peak demand based on their May 2008 IRP. Both data series exclude the off-system sale to NCEMC.

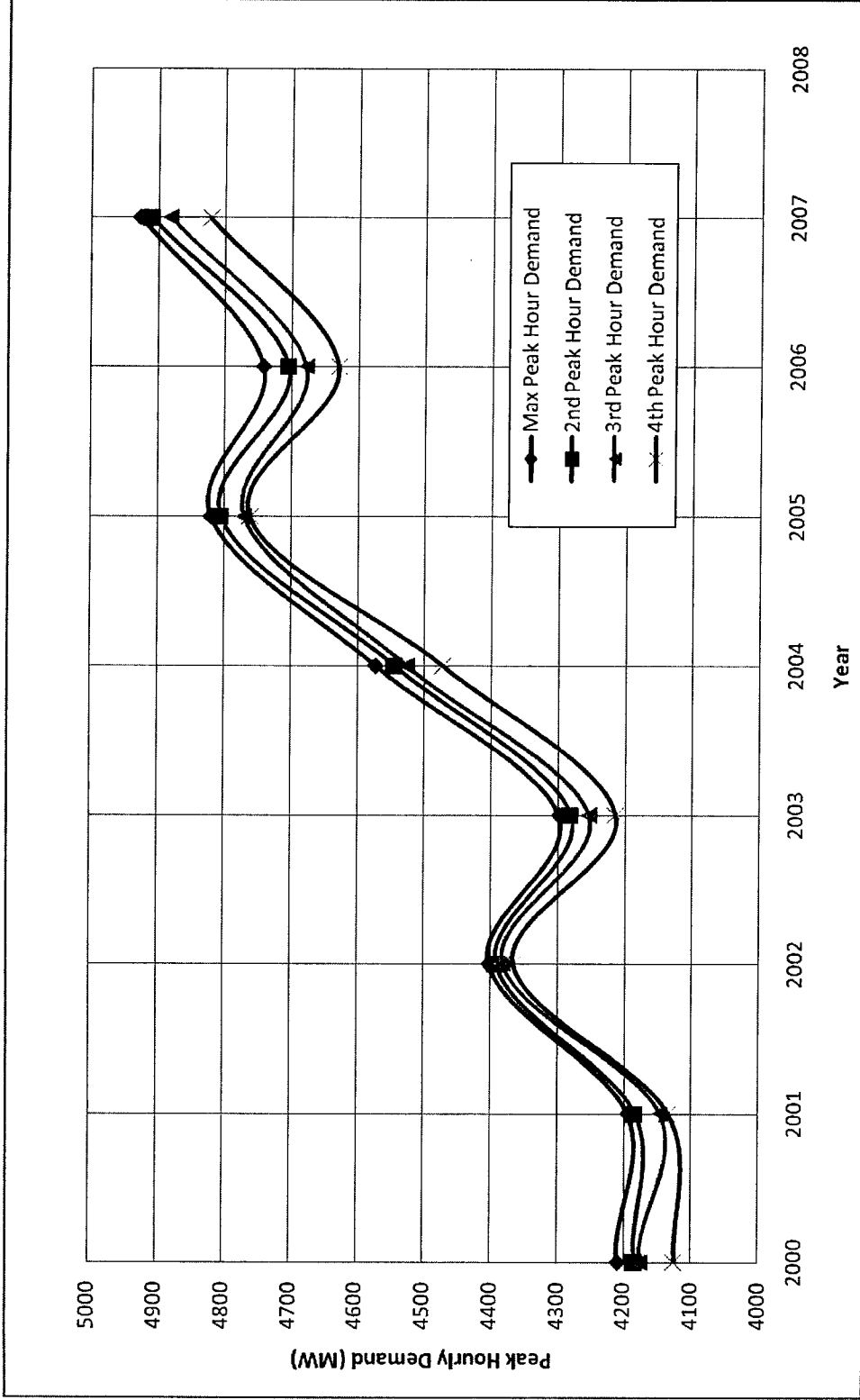


Figure 9. Time series of the peak hourly demand, 2<sup>nd</sup> highest peak hourly demand, 3<sup>rd</sup> highest peak hourly demand and the 4<sup>th</sup> peak hourly demand for each year from 2000 through 2007 for SCE&G (data from ORS Information Request 1-54).

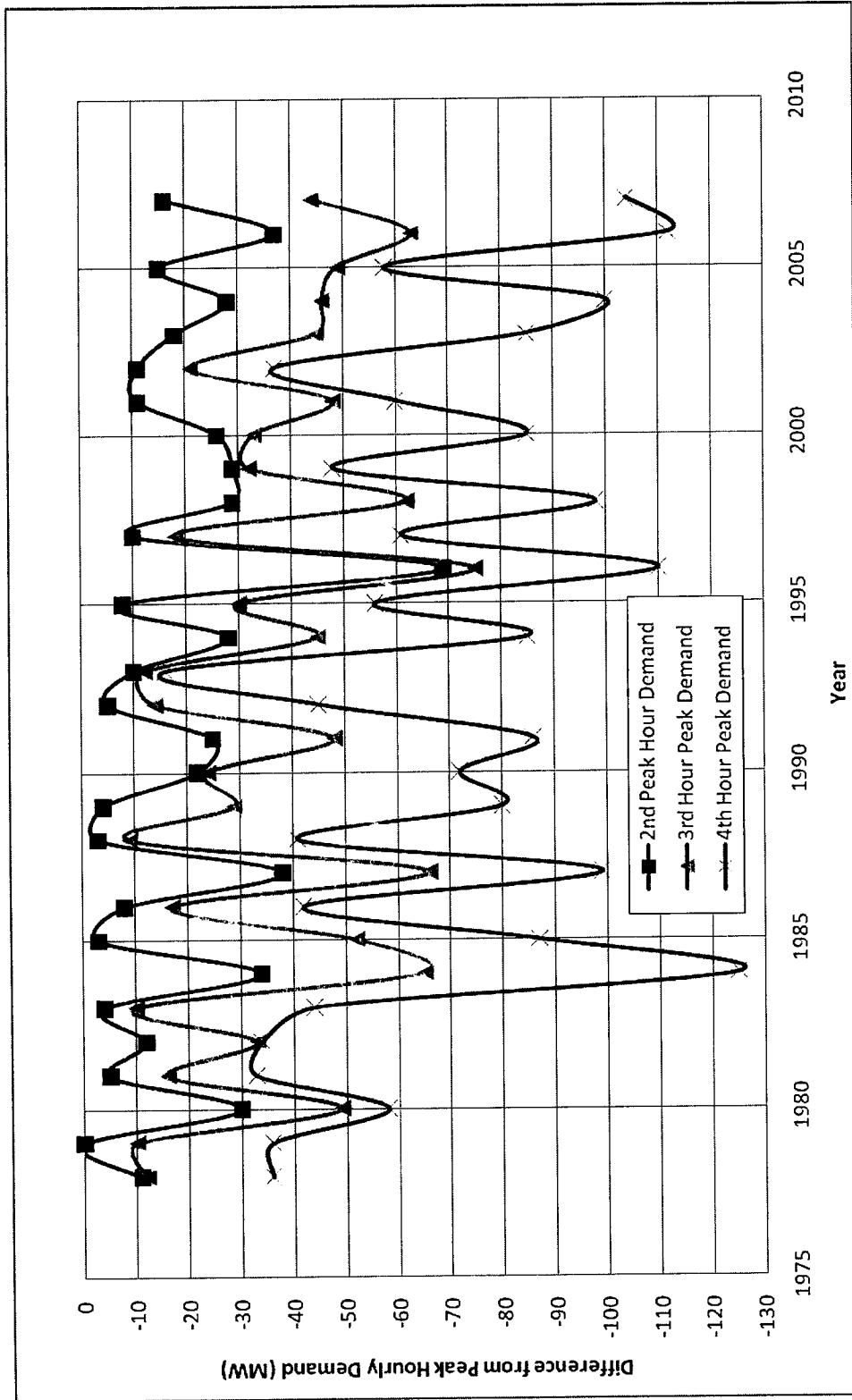


Figure 10. Time series of the differences between the peak hourly demand, and the 2<sup>nd</sup> highest peak, 3<sup>rd</sup> highest peak and the 4<sup>th</sup> peak hourly demand for each year from 2000 through 2007 for SCE&G (data from ORS Information Request 1-54).

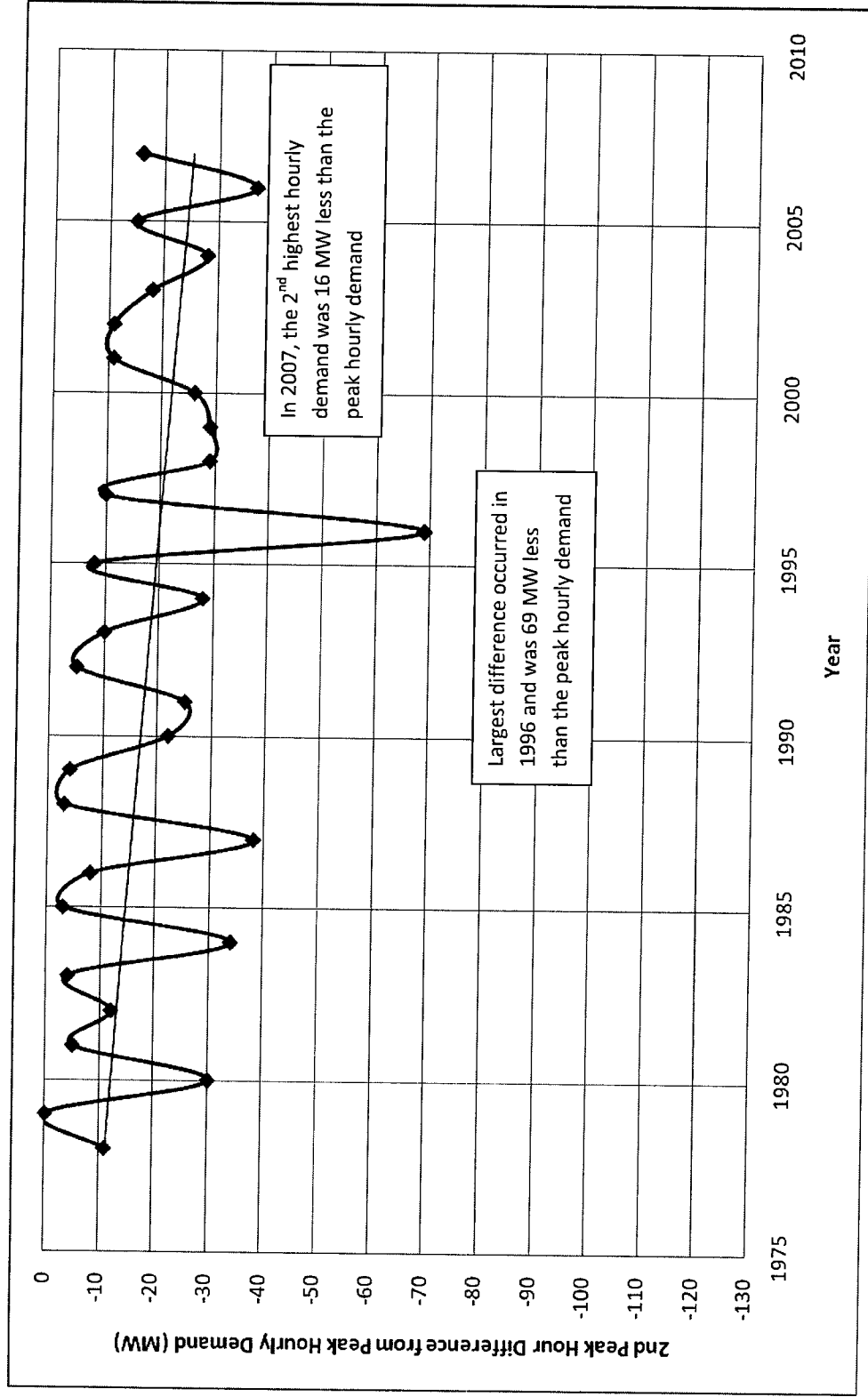


Figure 11. Time series of the differences between the peak hourly demand and the 2<sup>nd</sup> highest peak hourly demand for each year from 2000 through 2007 for SCE&G (data from ORS Information Request 1-54).

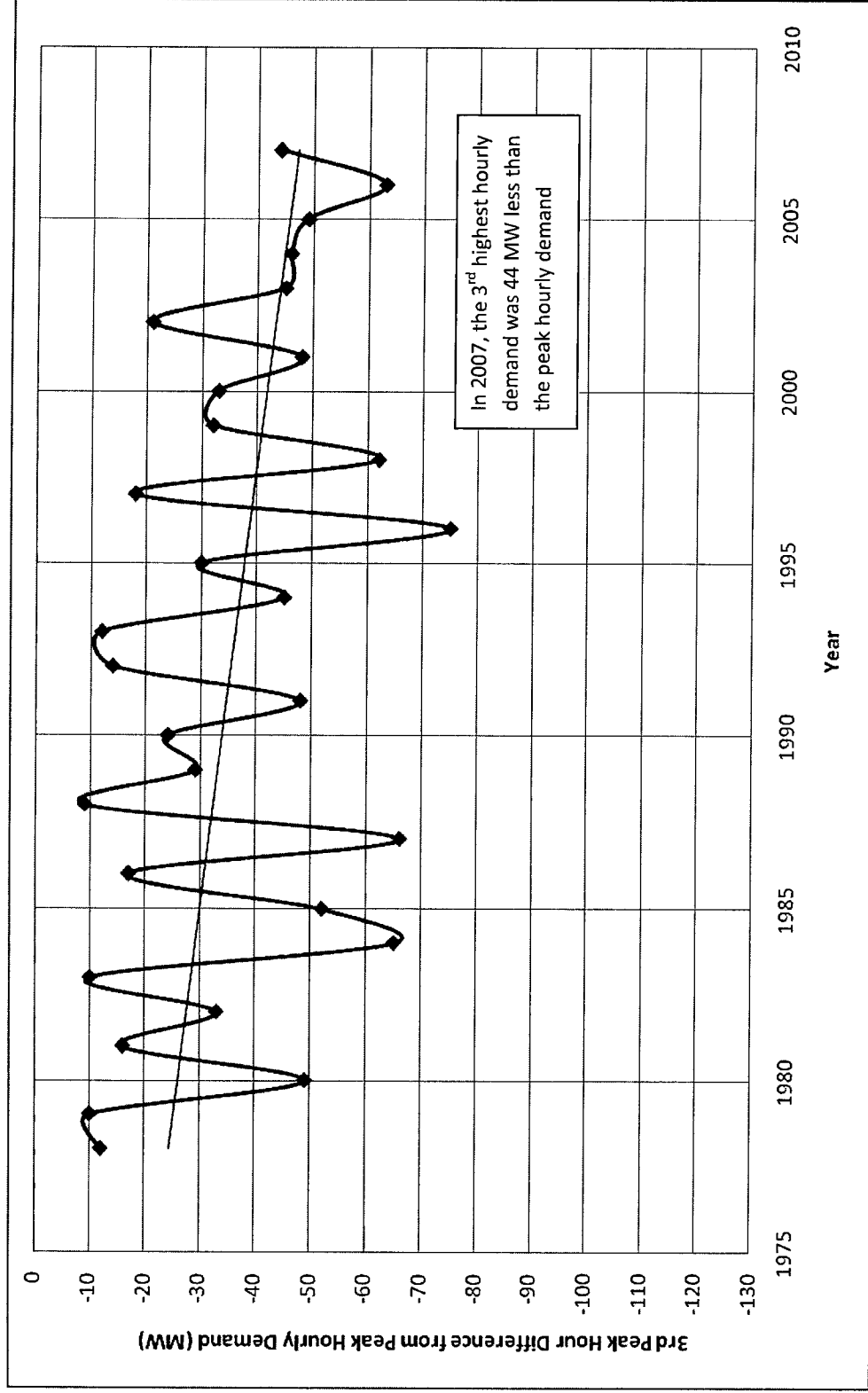


Figure 12. Time series of the differences between the peak hourly demand and the 3rd highest peak hourly demand for each year from 2000 through 2007 for SCE&G (data from ORS Information Request 1-54).

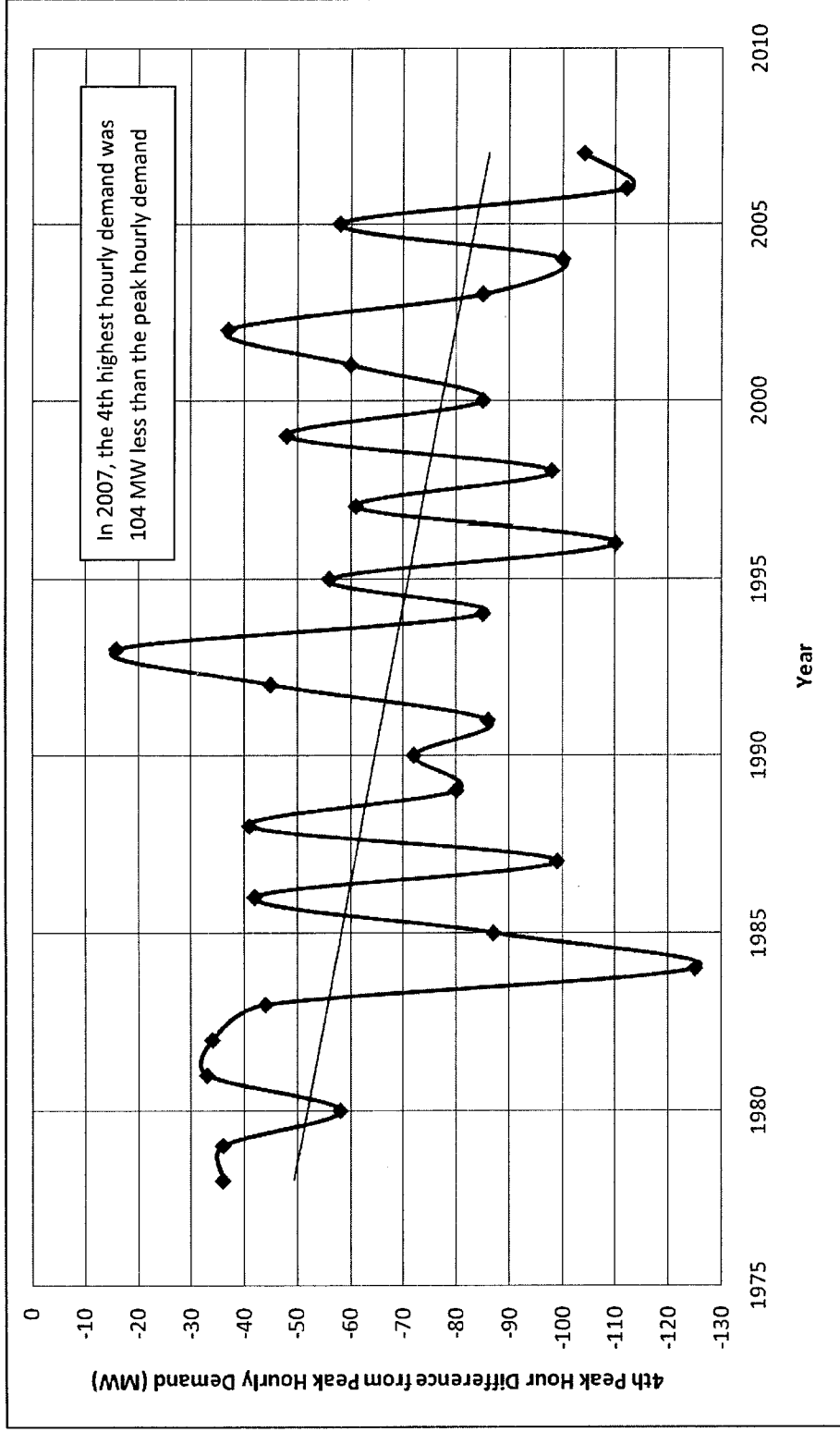


Figure 13. Time series of the differences between the peak hourly demand and the 4th highest peak hourly demand for each year from 2000 through 2007 for SCE&G (data from ORS Information Request 1-54).

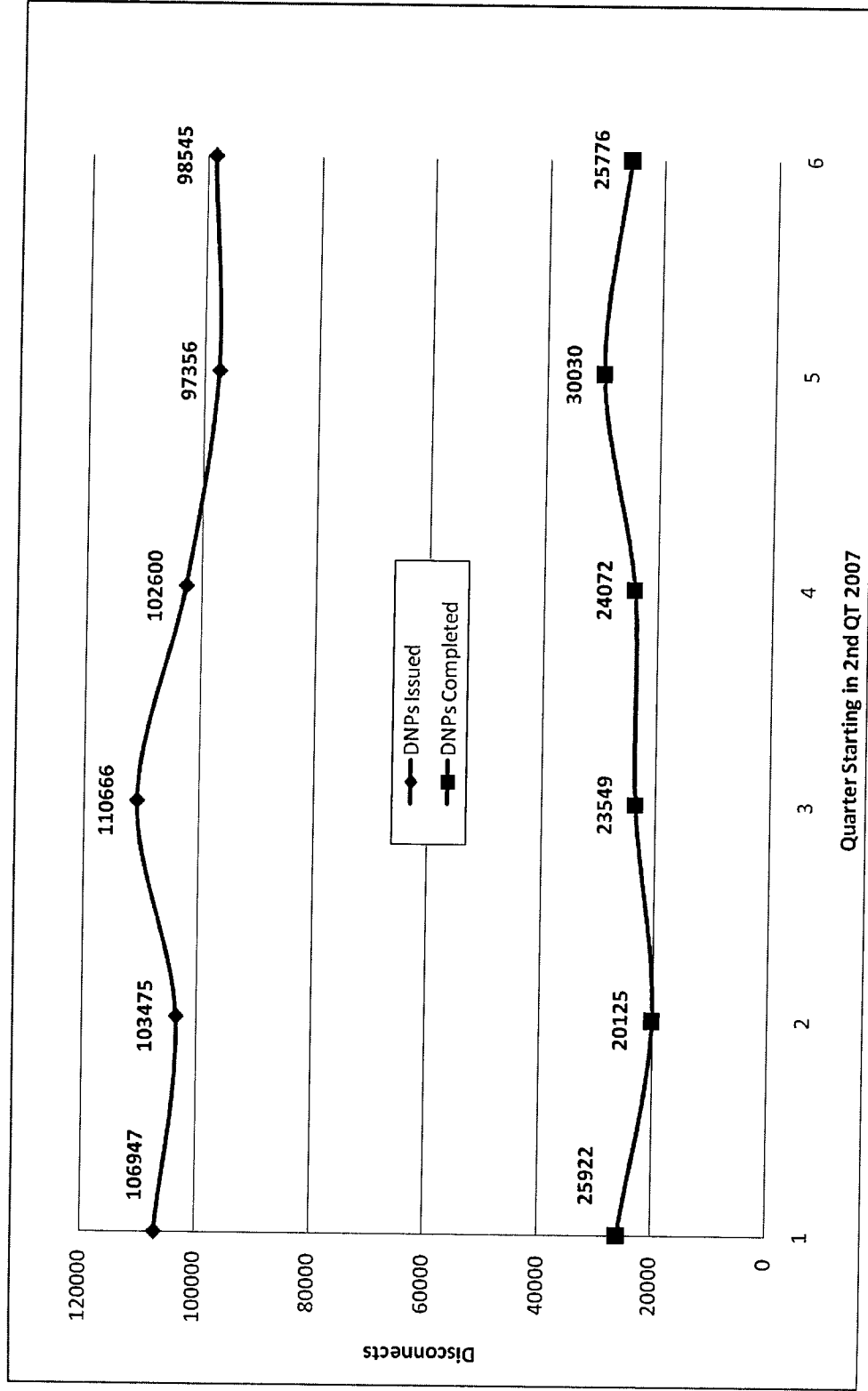


Figure 14. Time series, from the 2<sup>nd</sup> Qt 2007 through the 3<sup>rd</sup> Qt of 2008, of SCE&G's delinquent notice of payments issued and the total number completed during each quarter (data from Docket No. 2006-193 E/G).

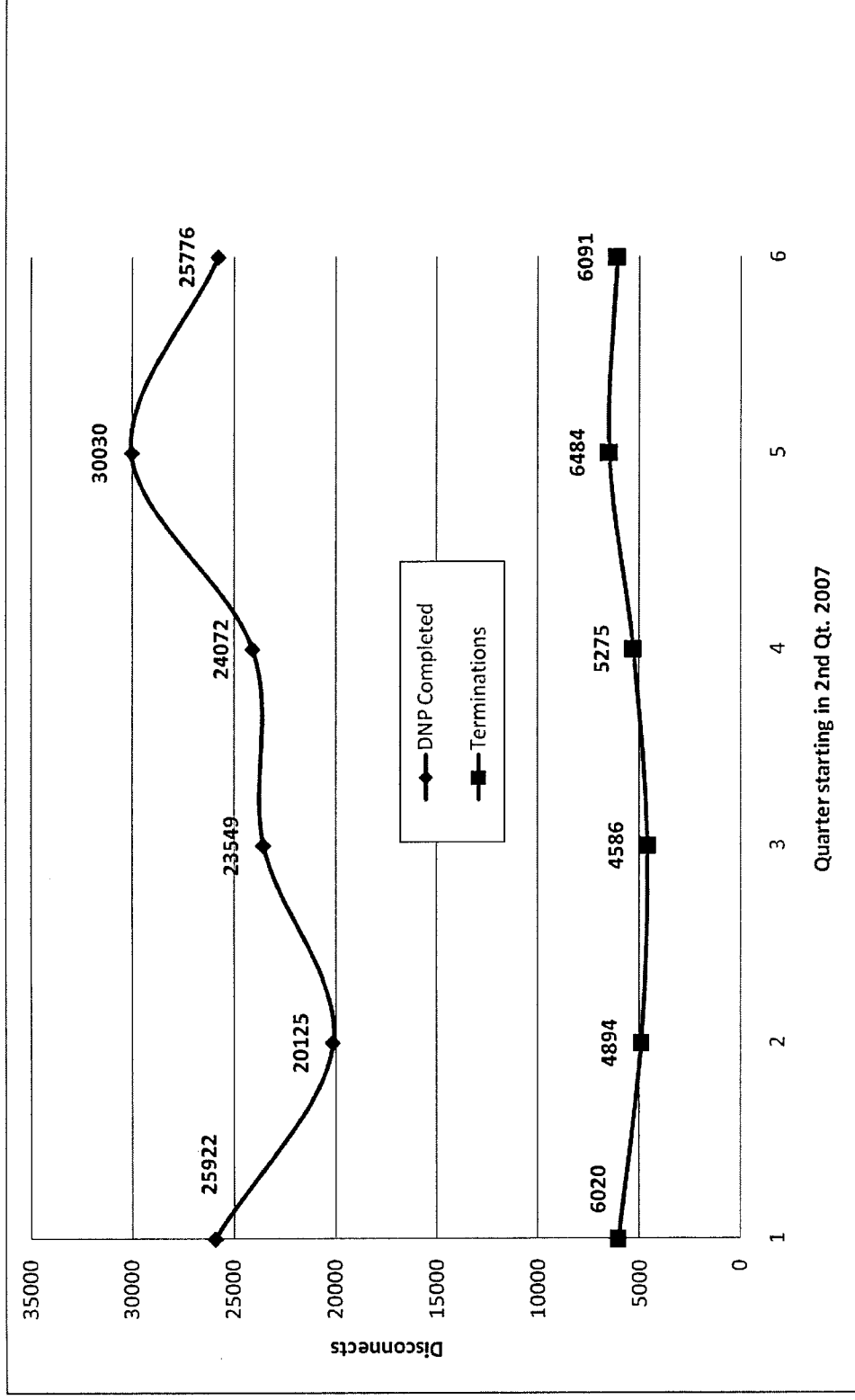


Figure 15. Time series, from the 2<sup>nd</sup> Qt 2007 through the 3<sup>rd</sup> Qt of 2008, of SCE&G's delinquent notice of payments completed and the resulting total number of terminations during each quarter (data from Docket No. 2006-193 E/G).

## **Measured Energy and Peak Demand Reduction from High Efficiency Air Conditioner Replacement**

**John A. Masiello and Matthew P. Bouchelle**

*Progress Energy Florida, Inc.*

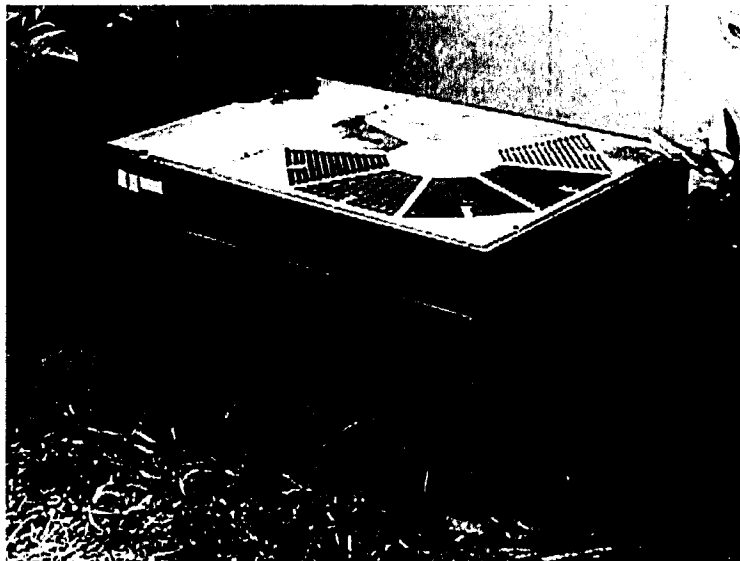
**Danny S. Parker and John R. Sherwin**

*Florida Solar Energy Center*

FSEC-PF-379-04

### **Abstract**

A utility load research project has monitored over 167 single-family residences in Central Florida collecting baseline 15-minute data on air conditioner (AC) power consumption, interior air temperatures and appliance loads over a two year period. Within the project we evaluated the impact of replacing older existing air conditioners with modern high efficiency equipment.



### **Air Conditioner Energy Use**

Most homes in Florida have central air conditioners which represent a very large energy end-use. Of the 167 single-family homes in the base sample in the residential monitoring project, 97% had central air conditioning systems. Within the statistically selected sample, total annual electricity use averaged 17,130 kWh. Of this total 6,421 kWh (37%) was used for cooling and 1,070 kWh (7%) for space heating (Parker, 2002).

### **Air Conditioner Retrofits**

Several field studies have shown that a 20 – 40% energy savings can be achieved by replacing less efficient AC units with higher ones (Parker, 1990; Burns and Hough, 1991; Ternes and Levins, 1992). These studies suggest that savings are strongly influenced by pre-retrofit consumption, with the highest users the most cost effective to improve. Energy

savings were found to scale reasonably well to the change in the pre and post SEER of the appropriate equipment. However, SEER rating is not necessarily an accurate predictor of AC peak kW (Proctor et al., 1994). Proper sizing of replacement equipment is also critical for reducing utility coincident peak loads (Neal and O'Neal, 1994).

Over the past decade, Florida utilities have sponsored many programs to install more efficient central air conditioners and heat pumps. However, few programs have monitored the impact of these changes to *both* monitored energy use and summer peak demand. Further, few if any studies have examined changes to occupant comfort from such retrofits.

Our project evaluated AC retrofits in five case-study homes where air conditioning power, interior temperatures and weather conditions were recorded. All project homes were metered for a full year prior to the AC retrofits in order to allow matches in month-long weather between the pre and post intervention periods. Three types of AC retrofits were performed: (1) change to higher efficiency single-speed equipment; (2) change to single-speed outdoor unit with a variable speed indoor unit and (3) change to two-stage outdoor compressors with a variable speed indoor blower. Variable speed indoor units are attractive in Florida since lower fan power increases efficiency while providing enhanced humidity removal through fan speed modulation.

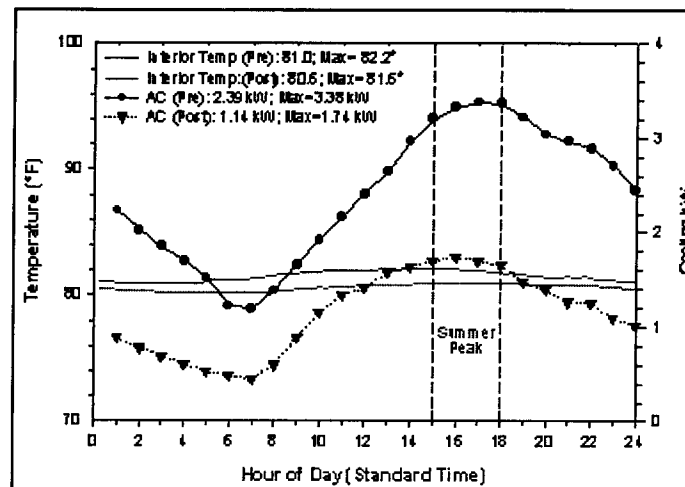
To analyze this data we created three graphical evaluations for each site. First, a scatter plot shows the average daily air conditioning consumption in the existing AC system compared with the retrofit system against the site measured interior to exterior temperature difference. A second plot shows AC power demand and interior temperature profiles for month long periods in the pre and post period with matched weather conditions. Average peak demand was defined as the maximum daily average hourly AC electricity requirement over month-long summer periods.

However, the summer peak demand comes when the utility experiences its peak summer system-wide demand during an hour. This came on August 30, 1999 prior to the retrofits and on August 8, 2000 after the retrofits were in place. The utility system peak came at 5 – 6 PM EDT (4-5 PM EST) on both days. Thus, for each AC retrofit, we show a third plot of the utility peak day before and after the retrofit, summarizing the peak hour demand reduction.

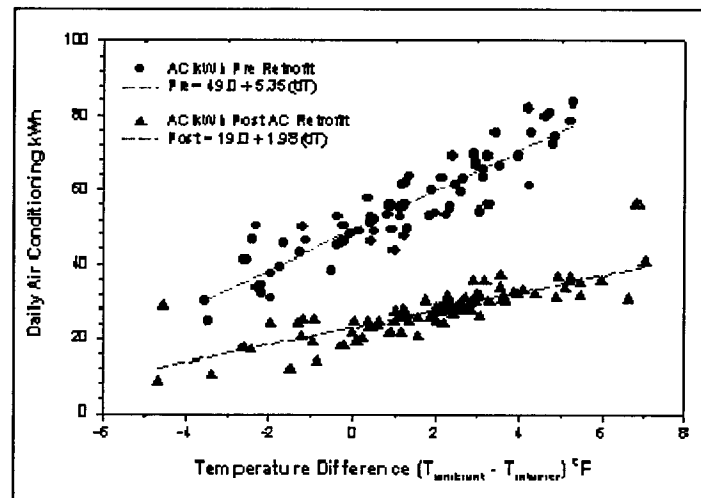
### **Site #197: Variable Speed Air Handler: 3-ton system**

Site #197 is a 1,764 square foot older home built in 1963, located in St. Petersburg and occupied by a family of six. The home has R-12 ceiling insulation and uninsulated concrete block walls. The roofing was originally white tile, changed over to white shingles. The homeowner maintains 79 oF inside during summer and 72 oF inside during colder winter period. The homeowner had the AC system replaced on June 9, 2000. The original system was older less efficient, *General Electric BGWC030A1D01*, packaged 2.5 ton AC (combination condenser and evaporator) which drew over 4 kW at full output. This was nominally about a 7.0 EER system. The new unit was a 3-ton *Trane XE1200* with a variable speed *TWE037E* air handler. The combination has a rated SEER of 13 Btu/W. This was the only site of the three single speed AC system retrofits which used a variable speed air handler. Figures 1 and 2 show, the energy and demand reductions at his home are very large. Figure 3 shows the performance on the utility peak days before and after retrofit.

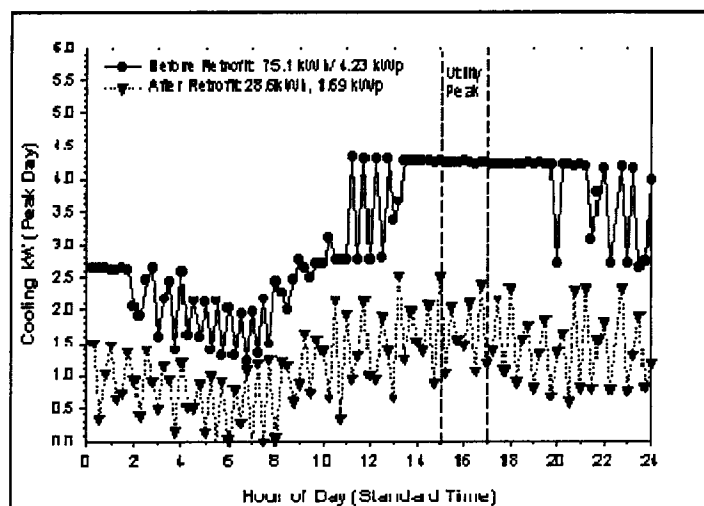
**Figure 1. Average AC Demand Profile for Site #197 Pre & Post**



**Figure 2. Site #197 of Average Daily AC Consumption Against Exterior to Interior Temperature Difference**



**Figure 3. Average Utility Peak Day Demand Profile for Site #197 Pre and Post**



Despite that the homeowner maintained an average 0.4 °F cooler temperature in August, the XE1200 with the variable speed air handler produced an average daily peak demand reduction of 2.43 kW (69%) and a cooling energy reduction of 45.7 kWh or 72%. Even on the post retrofit utility peak day, a 60% coincident peak hour demand reduction (2.54 kW) was seen. This is a good illustration of the advantage of the variable speed air handler.

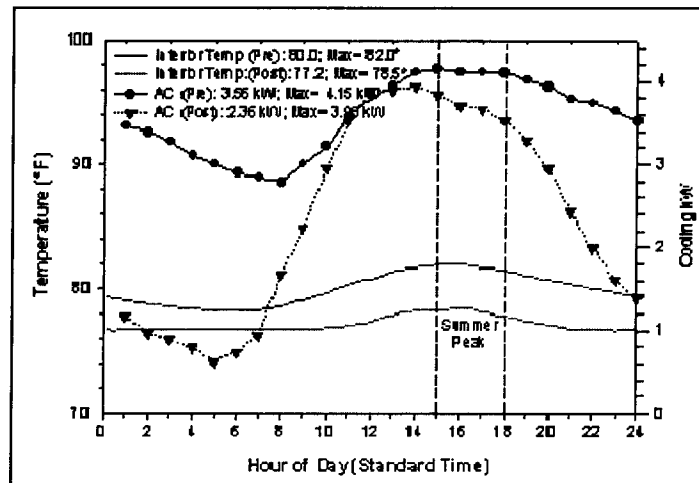
#### **Site #26: (4-ton, single-speed system)**

Site #26 is a 2,118 square foot home built in 1963, located in Casselberry, FL and occupied by a family of four. The home has R-8 ceiling insulation, a roof with dark asphalt shingles and uninsulated concrete block walls. The AC retrofit was performed on May 26, 2000. The original unit was a very old Armstrong 3.5 ton system, was replaced by a new *Intertherm T3BC 048K* 4-ton heat pump with a matching constant speed air handler (*B3BV-060K-C*). At full load the total system draws 4.3 kW (3.7 compressor, 0.6 kW on the air handler). The annual cooling consumption before the change out in 1999 was higher than any other monitored site (12,778 kWh).

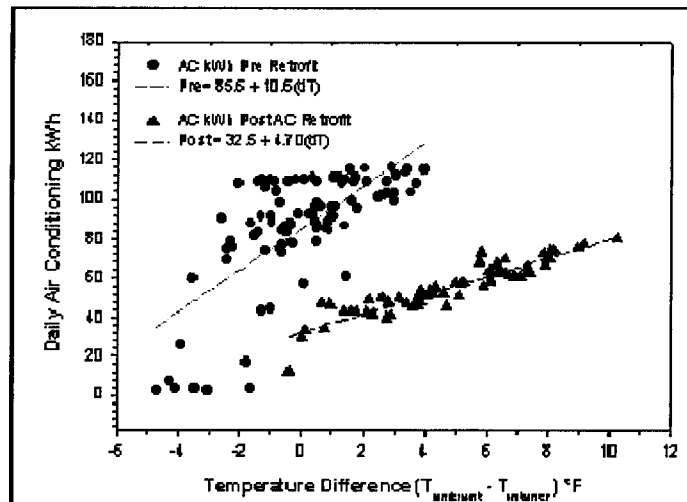
The comparative load data from June 1999 and June 2000 (Figures 4 and 5) reveals that while comfort improved (1 °F) and 36% energy savings (29.7 kWh) were achieved, average peak demand was reduced slightly by 4% (0.18 kW). This is disadvantageous to the utility as energy is reduced but demand is relatively unaffected. Part of this comes from take-back with the larger installed unit (0.5 tons) used to achieve greater comfort during the peak period. This emphasizes the hazards of up-sizing systems within utility AC replacement programs.

Figure 6 shows the performance on the utility summer peak day in 1999 compared with that in 2000. The older unit ran constantly the peak day before the change and was only able to maintain an interior temperature of 79-81 °F. After the change, the new AC system also runs constantly during the peak hour, but draws 1.3 kWh (26%) less.

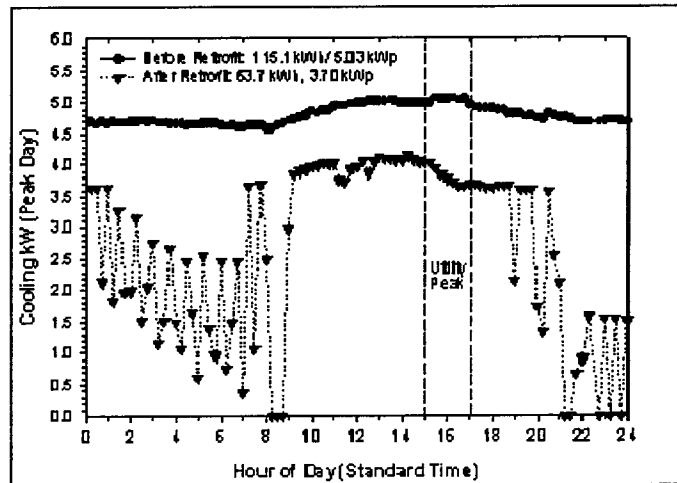
**Figure 4. Average AC Demand Profile for Site #26 Pre & Post**



**Figure 5. Site #26 of Average Daily AC Consumption Against Exterior to Interior Temperature Difference**



**Figure 6. Average Utility Peak Day Demand Profile for Site #26 Pre & Post**



### **Site #36: 3-ton single-speed system**

Site #36 is a modest 991 square foot home built in 1963, located in Seminole, Florida and occupied by a middle-aged couple. The home has R-12 ceiling insulation under a roof with dark asphalt shingles and uninsulated concrete block walls. The homeowners maintain 79-80 oF inside and 67 oF in winter. The home owner replaced the existing air conditioner on June 15, 2000. The old unit was an *Arcoaire WH0276AALE* 2-ton water-to-air heat pump which drew about 3.2 kWh when running constantly. The system was replaced a single-speed 3-ton unit which draws 3 kW when running constantly (2.5 kW compressor, 0.5 kW air handler).

Figures 7-9 show the performance in July of 1999 with the old system and July of 2000 with the new one. As with the other retrofits, the household enjoys better comfort (0.3 oF cooler) with the new system. Energy savings are also respectable at 26% (11.5 kWh) with an average summer day demand reduction 25% (0.77 kW). The utility peak day demand reduction during the peak hour in August was greater, 1.26 kW or 39% due to constant run of the older system under very hot weather conditions.

Figure 7. Average AC Demand Profile for Site #36 Pre & Post

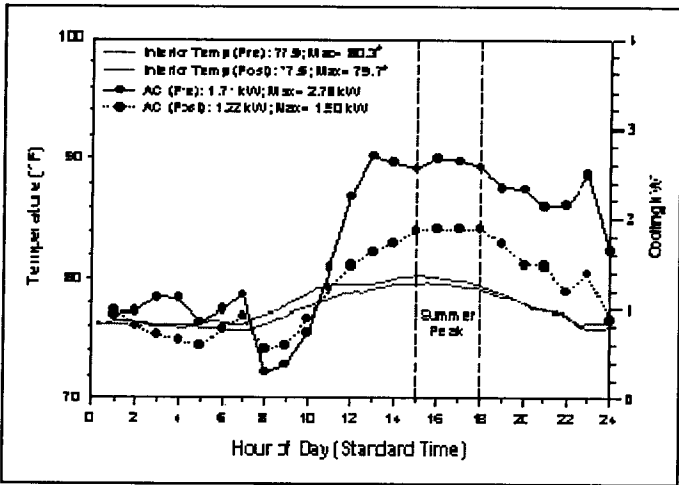
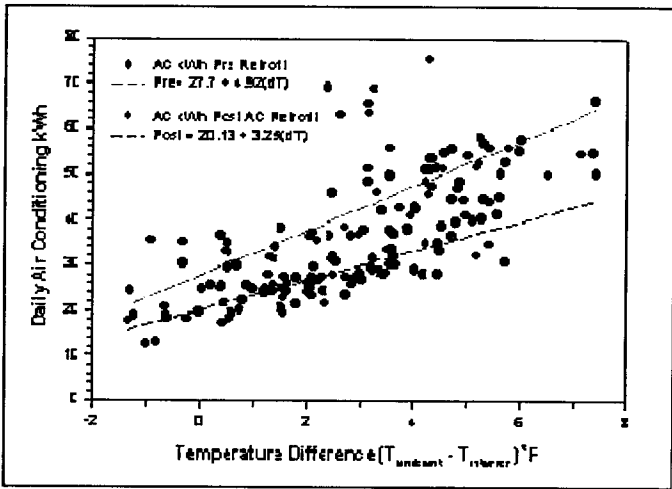
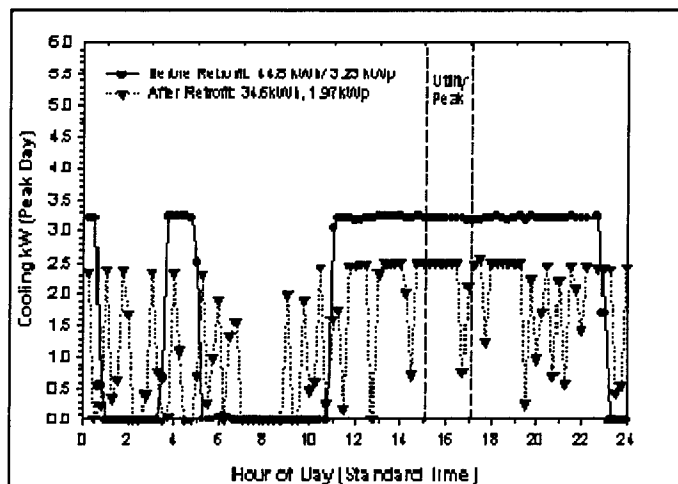


Figure 8. Site #36 of Average Daily AC Consumption Against Exterior to Interior Temperature Difference



**Figure 9. Average Utility Peak Day Demand Profile for Site #36 Pre & Post**



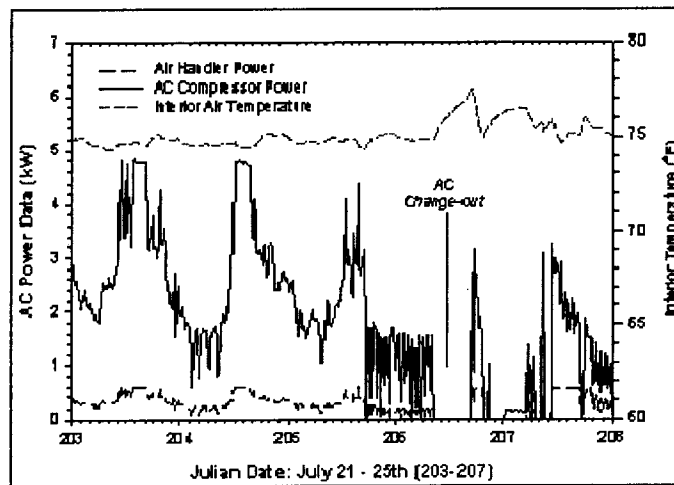
### **Air Conditioner Replacement with Two-Compressor Cooling Systems**

Two sites featured change out of the existing air conditioning system to a high-performance two-stage compressor cooling system developed by the *Trane Company*. These systems have nameplate SEERs up to 18 Btu/Wh when used with a variable speed air handler. Since the second stage cooling can be radio controlled with utility load control switches, this becomes an attractive option where second-stage cooling can be locked out during peak periods, but the customer continues cooling during the control window with primary stage operation.

#### **Site #75**

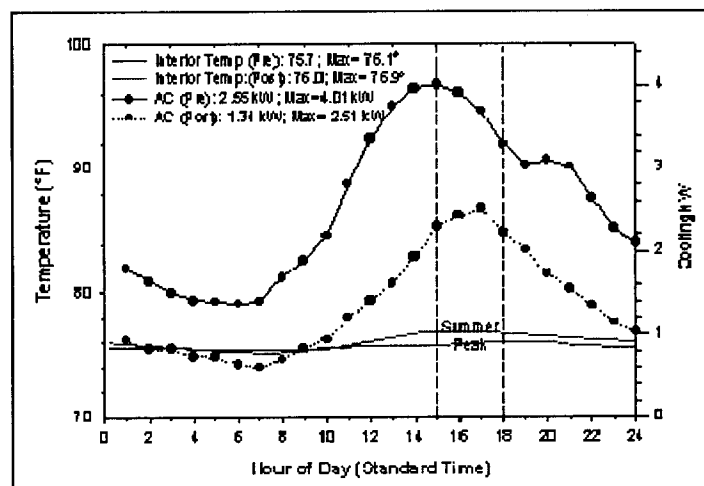
The first two-stage cooling system was installed at Site #75. This is a 2,363 square foot home built in 1982 in Clearwater, Florida and occupied by an older couple. The home has concrete block walls with R-3 insulation and R-19 ceiling insulation under gray asphalt shingle roofing. The homeowners maintain a set point of 75 oF inside during summer and 70 oF inside during winter. The original unit was an old 4-ton system of uncertain make which drew 5.9 kW (5.3 compressor, 0.6 kW on the air handler). *Manual J* indicated a 41,300 Btu/hr total cooling capacity. The AC unit was changed out on (Site #75) on July 24 th, 2000. The old unit was replaced by a new *Trane TWZ048A* 4-ton, two-stage heat pump with a matching air handler *TWE065E13FB*. Figure 10 is a time series plot showing the energy use and demand during six days after the system was changed.

**Figure 10. Change in AC Demand and Energy with AC Replacement at Site #75**

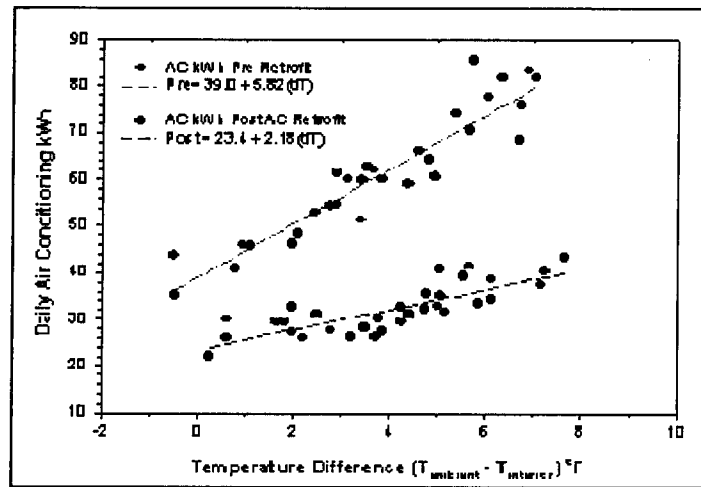


A month-long composite plot is shown in Figure 11, illustrating the site performance from June 23 - July 23, 1999 with the old system and July 25 - August 25th 2000 with the new one. The occupants maintained almost exactly the same temperature pre and post the system measurements and average weather conditions were well matched. Energy savings are very large at 47% (29.0 kWh/day) with an average summer day demand reduction of 37% (1.50 kW). A scatter plot shows a significant change to the slope of the daily cooling energy against the outside air temperature difference (Figure 12). Figure 13 shows a 32% demand reduction (1.61 kW) on the utility peak day during the system coincident peak hour.

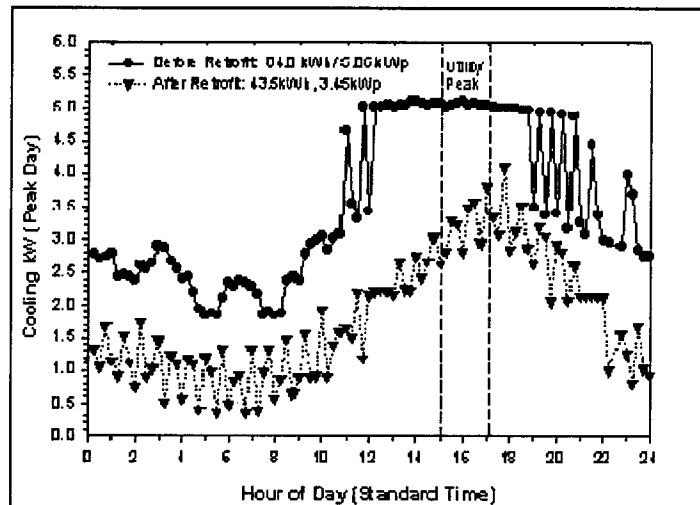
**Figure 11. Average AC Demand Profile for Site #75 Pre & Post**



**Figure 12. Site #75 of Average Daily AC Consumption Against Exterior to Interior Temperature Difference**



**Figure 13. Average Utility Peak Day Demand Profile for Site #75 Pre & Post**



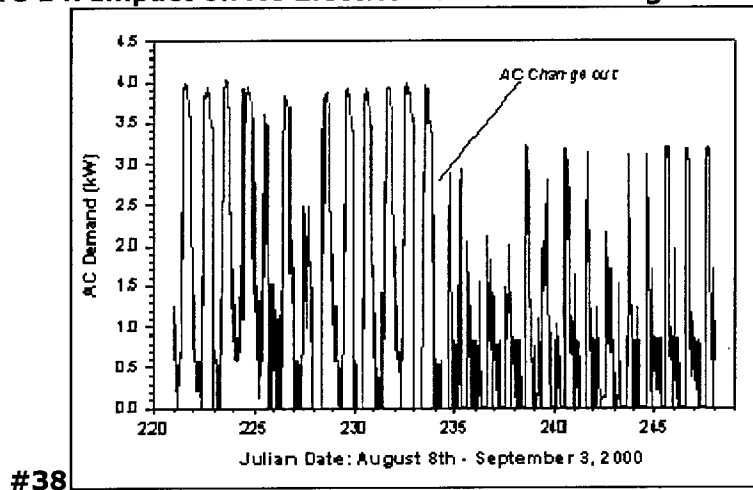
### Site #38

The second two-stage cooling system was installed at Site #38. This is a 1,827 square foot home built in 1973, located in Winter Park and occupied by a family of three. The home has R12 ceiling insulation and uninsulated concrete block walls. The roofing consists of brown asphalt shingles. The existing AC unit was a 17 year old *Janitrol* 3- ton system. The garage air handler was a *Rheem RENB1415JRS*. The homeowners claimed to maintain a set point of

78 oF inside during summer and 70 oF inside during winter. However, examination of the temperature maintained inside the home showed the customers were actually trying to maintain 74-76 oF. The original AC system draws 4.2 kW (3.7 compressor, 0.5 kW on the air handler).

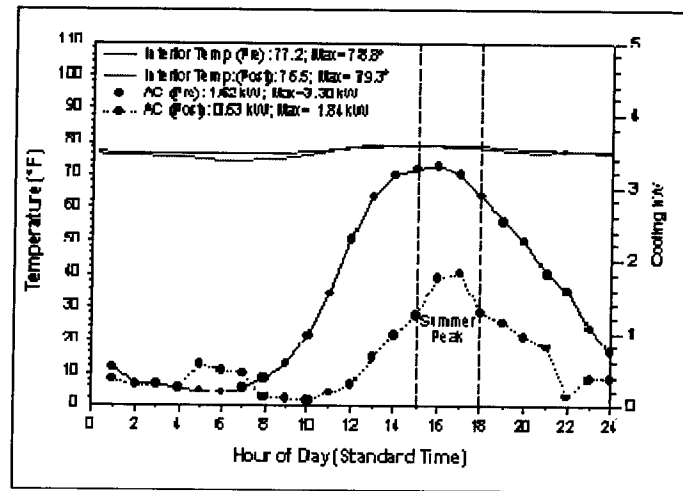
*Manual J* was used to size the replacement air conditioner, indicating a 27,000 Btu/hr unit. The AC unit was changed out on (Site #38) on August 21st, 2000. The old unit was replaced by a new *Trane TWZ036A* 3-ton, two-stage heat pump with a matching air handler *TWE040E13*. A plot of the AC demand during the two weeks before and after the new system installation is shown in Figure 14. It shows a very large impact on space cooling demand.

**Figure 14. Impact on AC Electric Demand of Change Out at Site**

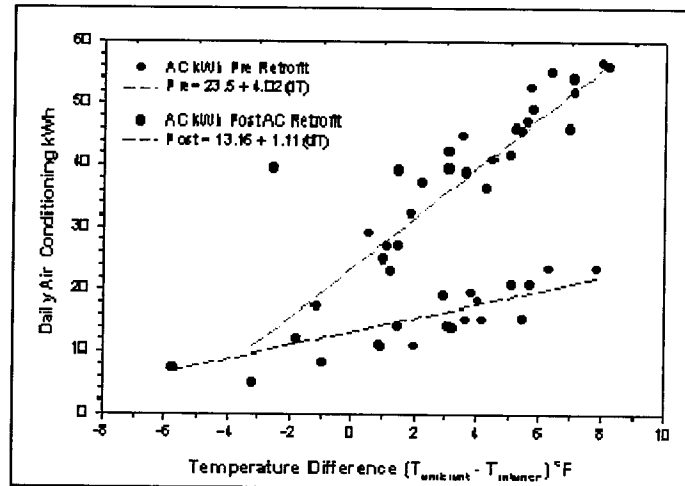


A month-long matched-weather composite demand plot is shown in Figure 15. This compares the performance at Site #38 in July 20- August 20th with the old system and August 22 - September 22nd 2000 with the new one. As with the other retrofits, Site #38 household enjoys better comfort (0.7 oF cooler) with the new system. Energy savings are very large at 59% (21.4 kWh/day) and similarly, a 44% (1.46 kWh) reduction in average summer day maximum demand. The scatter plot in Figure 16 shows a very large change to the slope of the AC demand against the outside air temperature difference. However, it was not possible to perform a comparison of the utility peak days pre and post as the new unit was not installed until after the peak day in 2000. Interestingly, however, the peak demand of the old unit on the two successive peak days was very similar – 3.7 kWh in 1999 and 3.9 kWh in 2000. As apparent from Figure 14, a large demand reduction would likely have been seen were the unit replaced earlier.

**Figure 15. Average AC Demand for Site #38 Pre & Post**



**Figure 16. Site #38 of Average Daily AC Consumption Against Exterior to Interior Temperature Difference**



### Impact of Air Conditioner Retrofits

A clear feature of the AC retrofits was that each produced savings with largest reductions on the hottest days – a positive attribute for utilities. The difference was greatest for the three systems with the variable speed air handler or VSAH (Sites #197, #38 and #75). Sites #38 and #75 have the two-compressor cooling system also with variable speed air handlers. Theoretically, these systems will allow even greater demand reduction than the 30-40% already being achieved since the second stage cooling could be interrupted during load control periods by radio control signal.

Table 3 offers a comparative evaluation of the two conventional air conditioner retrofits and three others which include the variable speed air handler. Two of the later feature the two-stage air conditioning system. Although case studies, systems with the VSAH look to produce both energy and demand savings in the 40 - 50% range when compared with

replacement of older equipment. The energy savings for conventional equipment looks to be lower – in the 30% range.

Variable speed air handlers offer other advantages in residential application. For instance, their electronically commutated motors (ECMs) are 15% more efficient at full speed and offer electric demand reduction even under full load operation. Further, they adapt to changes in fan static pressure to provide rated indoor coil air flow, improving cooling performance. They are also much more efficient at slower speeds such as those experienced during heating conditions. They are typically set up to yield a slow start, providing more quiet operation with greater humidity removal at slower fan speeds. As observed by Khattar et al. (1985) and more recently by Shirey and Henderson (2004), the modulation of fan speed with longer compressor run times can be particularly desirable in hot-humid climates.

**Table 3**  
**Air Conditioner Retrofit Performance Results**

<i>Conventional AC Retrofits</i>			
<b>Site</b>	<b>Daily Avg. AC Use</b>	<b>Daily Avg. Peak Demand</b>	<b>Utility Peak Hour Demand</b>
Site #36 (Pre)	41.0 kWh	2.70 kW	3.23 kW
(Post)	29.3 kWh	1.90 kW	1.97 kW
<i>Savings</i>	<i>11.7 kWh (29%)</i>	<i>0.80 kW (30%)</i>	<i>1.26 kW (39%)</i>
Site #26 (Pre)	85.4 kWh	4.15 kW	5.03 kW
(Post)	56.6 kWh	3.95 kW	3.70 kW
<i>Savings</i>	<i>28.8 kWh (34%)</i>	<i>0.20 kW (5%)</i>	<i>1.33 kW (26%)</i>
<i>Variable Speed Air Handlers</i>			
Site #197 (Pre)	57.4 kWh	3.38 kW	4.23 kW
(Post)	27.4 kWh	1.74 kW	1.69 kW
<i>Savings</i>	<i>30.3 kWh (52%)</i>	<i>1.64 kW (49%)</i>	<i>2.54 kW (60%)</i>
Site #75 (Pre)*	61.2kWh	4.01 kW	5.06 kW
(Post)	32.2 kWh	2.51kW	3.45 kW
<i>Savings</i>	<i>29.0 kWh (47%)</i>	<i>1.50 kW (37%)</i>	<i>1.61 kW (32%)</i>
Site #38 (Pre)*	36.5kWh	3.30 kW	3.69 kW
(Post)	15.1 kWh	1.89 kW	NA
<i>Savings</i>	<i>21.4 kWh (59%)</i>	<i>1.46 kW (44%)</i>	NA

\* Two compressor cooling system

## Conclusions

A Florida utility monitoring project found air conditioner retrofits can provide large energy savings and significant reductions to summer day peak demand. Two evaluated retrofits had older single-speed AC systems replaced with the same type, but of newer vintage. Here the cooling savings were 29% and 34%, with an average savings of 20.2 kWh/day. The reduction in average daily summer peak demand was 30% and 5% respectively, with an

average reduction of 0.30 kW. An appreciable amount of customer comfort take-back was observed with lower demand reduction – particularly in the second site where the newer unit was sized larger. Although case study results indicate typical energy use and demand savings from conventional AC replacement are about 25%, it also suggests that proper sizing of retrofit equipment may be vital to achieving effective utility coincident peak demand reduction.

In a second part of the pilot project, three customers' units were replaced with very high efficiency air conditioners. One system featured a SEER 13 system with single-speed compressor coupled with a variable speed air handler (VSAH). Measured cooling energy was cut by 52% (30.3 kWh) with a 49% reduction to average demand (1.64 kW). Two additional sites had the VSAH matched with a two-compressor AC system with seasonal efficiencies over 17 Btu/Wh. Average electrical consumption in these two sites was cut by 47% and 59% percent respectively (29.0 and 21.4 kWh/day), with reductions to average daily maximum demand of 37% and 44% (1.50 and 1.46 kW). Reductions to utility coincident peak demand were even greater. Our case studies indicate high-performance AC systems with VSAH can achieve energy savings averaging about 50% with reductions to peak demand of 35-50%.

In conclusion, air conditioner retrofits show promise to significantly reduce cooling energy and demand. Systems with variable speed air handlers showed largest impacts to both energy and peak reductions and could form the basis for effective utility programs to help control summer afternoon peak demand. Variable speed air handlers also have the side benefits of better adapting to changes in duct static pressure to provide rated air flow, more quiet operation and potentially improved moisture removal in humid climates.

### **Acknowledgement**

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## City's light show to save energy

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Columbia officials plan to replace every light bulb in city buildings and parking garages with more energy-efficient bulbs over the next nine months, saving the city about \$255,000 a year in energy costs.

It is the first phase of a sweeping energy plan, unveiled Wednesday, that includes installing a new heating and air-conditioning system at City Hall and putting solar panels on the city's fire stations.

The biggest change will be for parking garages, which use high intensity discharge, or HID, lights. The city will replace them with light-emitting diode, or LED, lights, which last longer, use less electricity and generate less heat.

The plan comes after Columbia officials paid Ameresco, an energy consulting firm, \$63,000 to study the city's buildings and how the city uses energy.

It will cost \$2.1 million to install the lights in city buildings, which include City Hall, fire stations, the police department and the Drew Wellness Center. Even the exit sign lights will be replaced.

The city's projected power bill this year is about \$7 million. Over 10 years, the new lights will save the city \$3.2 million.

"It's like finding money," said City Councilman Kirkman Finlay. "The savings are great, and we are going to realize them quickly."

The city is borrowing the money to pay for the lights, senior assistant city manager Steve Gantt said. After interest over 10 years, the city will have to pay back about \$2.9 million. But with the projected savings for lighting, the city is scheduled to make \$272,510 off the deal.

The city will seek bids for the light installation. But if it uses Ameresco, it would be a performance-based contract — meaning if the city doesn't save enough money to pay off the loan, Ameresco would pay the difference.

"If Ameresco goes away, who is on the hook for that \$25.8 million? The reality is we would be," city manager Charles Austin said. "We believe going forward with the pilot program is feasible, and we support that."

The energy plan Ameresco developed would cost \$25.8 million to implement and would save about \$25.9 million in energy costs.

But some of the recommended projects, including converting the wastewater treatment plant to operate partially on methane gas, would cost more than \$10 million and take more than 15 years to pay back.

Columbia isn't the first S.C. city to have an energy audit, with Charleston and Greenville going through similar processes. Ameresco is also representing The Citadel and the Medical University of South Carolina.

"We've got to save energy, reduce our carbon footprint, and we have to do things that make sense financially," Mayor Bob Coble said. "This is an important step to being a green city."

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